

CONNECTICUT RIVER FLOOD CONTROL

COLEBROOK RIVER DAM & RESERVOIR

WEST BRANCH, FARMINGTON RIVER
CONNECTICUT & MASSACHUSETTS

DESIGN MEMORANDUM NO. 6

**GENERAL DESIGN
(REVISED)**

**THIS GENERAL DESIGN MEMORANDUM
SUPERSEDES MEMORANDUM DATED MARCH 1964**



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

JANUARY 1965

TC423

.N43C691 Colebrook River dam and reservoir; West
1965 branch, Farmington River, Connecticut
and Massachusetts: design memorandum
no. 6: general design (revised). --
Waltham, Mass. : U.S. Army Engineer
Division, New England, 1965.

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control.) (Design memorandum no. 6:
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This general design memorandum
supersedes memorandum dated March 1964.
"January 1965"

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TC423

.N43C691 Colebrook River dam and reservoir; West
1965 branch, Farmington River, Connecticut
and Massachusetts: ... 1965.

(Card 2)

1. Flood control--Connecticut--
Colebrook River. 2. Colebrook River
watershed (Conn.)--Flood control.
3. West Branch Reservoir (Conn.)--Flood
control. 4. Farmington River watershed
(Mass. and Conn.)--Flood control.
5. Connecticut River watershed (Mass.
and Conn.)--Flood control. I. United
States. Army. Corps of Engineers. New
England Division. II. Series
III. Series: Design memorandum no. 6:
general design (revised).

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**U. S. ARMY ENGINEER DIVISION. NEW ENGLAND
CORPS OF ENGINEERS**

**424 TRAPELO ROAD
WALTHAM, MASS. 02154**

**ADDRESS REPLY TO:
DIVISION ENGINEER**

REFER TO FILE NO.

NEDED-D

28 January 1965

SUBJECT: Colebrook River Dam and Reservoir, Farmington River, Connecticut River Basin, Connecticut and Massachusetts, Design Memorandum No. 6, General Design Memorandum, Revised

TO: Chief of Engineers
ATTN: ENGOW-E
Department of the Army
Washington, D. C. 20315

1. There is submitted herewith, for review and approval, Design Memorandum No. 6, General Design Memorandum, Revised, for the Colebrook River Dam and Reservoir, Farmington River, Connecticut River Basin, in accordance with EM 1110-2-1150.

2. This General Design Memorandum supersedes the original General Design Memorandum, submitted in March 1964 and approved on 4 June 1964. The principal revision is the addition of fisheries storage under the provisions of Public Law 85-624 in accordance with recommendations of the Fish and Wildlife Service.

3. By letter of 1 June 1964, the Fish and Wildlife Service indicated that provision of a fisheries pool for summer and fall releases would provide a potential for development of sea-run brown trout. A "Report on Provision of Fishery Storage in Colebrook River Dam and Reservoir, Farmington River, Connecticut River Basin, Connecticut and Massachusetts", was submitted to your office on 16 July 1964 with request for "approval in principle" of including fisheries storage pending resubmission of the General Design Memorandum.

4. By 1st Indorsement thereon, dated 6 August 1964, provision of fisheries storage was approved "in principle" subject to certain comments and questions. These were partially resolved in our 2nd Indorsement of 1 September 1964 which stated that a permanent pool is warranted now as an interim measure pending furnishing of assurances. No effort was made at that time to obtain necessary comments from State and local agencies as such requests would, in all probability, result in premature publicity.

NEDED-D

28 January 1965

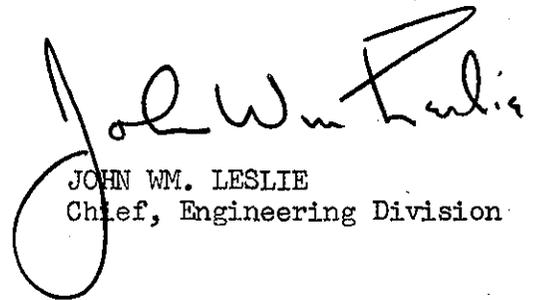
SUBJECT: Colebrook River Dam and Reservoir, Farmington River, Connecticut River Basin, Connecticut and Massachusetts, Design Memorandum No. 6, General Design Memorandum, Revised

5. By your 3rd Indorsement of 2 October 1964, fish and wildlife was approved as a primary project purpose with the understanding that (1) the State of Connecticut, through its Department of Agriculture and Natural Resources, will actively pursue the steps necessary to acquire the required water rights and the modification of existing downstream facilities where required, and (2) that, in any event, this additional storage is incrementally justified as a reservoir, recreational, and fishery pool.

6. After a study of existing legislation, the Connecticut Board of Fisheries and Game determined that it can enter into cooperative agreements to provide for the water rights. They are negotiating with the riparian owners and planning the fishway improvements. Reservoir fishery benefits alone warrant the provision of the fisheries pools.

FOR THE DIVISION ENGINEER:

Incl (10 cys)
Des Memo No. 6, Rev.



JOHN WM. LESLIE
Chief, Engineering Division

FLOOD CONTROL PROJECT
COLEBROOK RIVER DAM AND RESERVOIR
WEST BRANCH FARMINGTON RIVER
CONNECTICUT RIVER BASIN
CONNECTICUT AND MASSACHUSETTS
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<u>No.</u>	<u>Title</u>	<u>Date Submitted</u>	<u>Date Approved</u>
1	Site Selection	13 Mar 1963	11 Apr 1963
2	Hydrology Preliminary Final	3 Jul 1963 12 Nov 1963	10 Jul 1963 19 Dec 1963
3	Site Geology	12 Jun 1964	9 Jul 1964
4	Real Estate	16 Oct 1964	4 Dec 1964
5	Relocations	31 Mar 1964	3 Jun 1964
6	General Design	31 Mar 1964	4 Jun 1964
6	General Design (Revised)	28 Jan 1965	
7	Concrete Materials	27 Sep 1963	18 Oct 1963
8	Hydraulic Analysis	30 Apr 1964	9 Jun 1964
9	Embankments & Foundations	12 Jun 1964	24 Jul 1964
10	Detailed Design of Structures	17 Sep 1964	26 Oct 1964
11	Reservoir Development (Preliminary)	30 Apr 1964	2 Sep 1964
11A	Reservoir Development (Master Plan)		

FLOOD CONTROL PROJECT
COLEBROOK RIVER DAM AND RESERVOIR
WEST BRANCH FARMINGTON RIVER
CONNECTICUT RIVER BASIN
CONNECTICUT AND MASSACHUSETTS

DESIGN MEMORANDUM NO. 6
GENERAL DESIGN MEMORANDUM

REVISED

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COLEBROOK RIVER DAM AND RESERVOIR
WEST BRANCH FARMINGTON RIVER
CONNECTICUT RIVER BASIN
CONNECTICUT

A. PERTINENT DATA

1. Purpose Flood Control, Water Supply, and Fish and Wildlife

2. Location of Dam

State	Connecticut
County	Litchfield
Town	Colebrook
River	West Branch Farmington River, 3.9 river miles upstream from confluence with Still River

3. Drainage Areas

Square Miles

West Branch Farmington River, Gaging Station near New Boston, Mass.	92
West Branch Farmington River at Damsite	118
West Branch Farmington River at Goodwin Dam	120
West Branch Farmington River at Gaging Station Above Still River at Riverton	130
Farmington River at mouth, confluence with Connecticut River	602

4. Stream Flow

Record of U.S.G.S. Gaging Station on West Branch Farmington River near New Boston, Massachusetts, June 1913 - September 1961.

<u>Time</u>	<u>c.f.s.</u>
Average annual	184
Maximum year (1928)	341
Minimum year (1957)	93.1
Maximum month (August 1955)	1,002
Minimum month (August 1957)	5.68
Maximum day (19 August 1955)	16,100

5. Maximum Floods of Record

Record of U.S.G.S. Gaging Station on West Branch Farmington River near New Boston, Massachusetts

<u>Time</u>	<u>c.f.s.</u>
19 August 1955	34,300
21 September 1938	18,500
31 December 1948	11,700
18 March 1936	9,080
16 October 1955	7,910
3 November 1927	6,610

6. Criteria for Spillway Design Flood

Peak inflow to reservoir, c.f.s.	165,000
Total volume of rainfall, inches	23.7
Infiltration rate, inches per hour	0.07
Total volume of runoff, acre-feet	133,000
Total volume of runoff, inches	21.2
Duration of flood, hours	27
Reservoir stage at start of flood, ft., m.s.l.	750
Outlet works, (6" F.C. storage utilized)	In operation and discharging 4,000 c.f.s.

7. Reservoir

Towns and counties affected:

Colebrook, Litchfield County, Connecticut, Sandisfield, Berkshire County, Massachusetts and Tolland, Hampden County, Massachusetts.

Elevations, Areas and Capacities

<u>Pool</u>	<u>Elevation Ft.m.s.l. (approx.)</u>	<u>Area Acres</u>	<u>Acre Feet (net)</u>	<u>Inches On Drainage Area (approx.)</u>
Dead Storage and Sedimentation Conservation Water Supply Existing (West Branch Reservoir)	598	90	1,000	0.2
Replacement *	641	355	10,000	1.7
	644	370	1,000	

Elevations, Areas and Capacities (Cont'd)

<u>Pool</u>	<u>Elevation</u> <u>Ft., m. s. l.</u> <u>(approx.)</u>	<u>Area</u> <u>Acres</u>	<u>Acre</u> <u>Feet</u> <u>(net)</u>	<u>Inches On</u> <u>Drainage Area</u> <u>(approx.)</u>
Immediate Use	677	555	15,350	2.4
Future Use	701	710	15,350	2.4
Fishery**	708 ✓	750	5,000 ✓	0.8
Joint Use				
Flood Control and Fishery Conservation	714.5	800	5,000	8.0
Flood Control	761	1,210	45,800	
(Total Flood Control Storage 45,800 a.f. plus 5,000 a.f.) = 50,800 a.f.				
TOTAL			98,500	15.5

* Storage for replacement of dead and sedimentation storage.

** Fishery conservation storage to be "permanent" until necessary water rights are provided. Thereafter, it will be operated for downstream fishery improvement.

8. Dam

Type	Rolled earth and rock fill
Top width, feet	30
Maximum base width, feet	895
Maximum height, feet	223
Total length, feet	1300
Slopes upstream and downstream	1 on 2, below Elevation 780 1 on 1-3/4 Elevation 780 to El. 790
Freeboard above spillway design height, feet	5.0

Elevations (feet above mean sea level)

Top of dam	790.0
Base of dam (stream bed at centerline)	567.0
Maximum surcharge (Spillway Design Flood)	785.0
Top Water Supply Pool	701.0
Top Fishery Conservation Pool	708.0
Top Flood Control Pool, Spillway Crest	761.0

9. Dike

Type	Rolled earth fill
Top width, feet	30
Maximum base width, feet	320
Maximum height, feet	54
Total length, feet	1240
Slopes, upstream and downstream	1 on 2-1/2

10. Spillway

Type	Uncontrolled chute
Crest length, feet	205
Elevation of crest, feet, msl	761
Maximum head, feet (above spillway crest)	24
Maximum inflow from spillway design flood, c.f.s.	165,000
Spillway peak discharge, c.f.s.	92,000

11. Outlet Works

Type	Tunnel in rock
Tunnel, inside diameter, feet	10
Length of tunnel, portal to portal, feet	774
Length of inlet channel, feet	450
Tunnel invert elevation, feet, m.s.l.	575

Service Gates

Number	3
Size	4' x 8'
Type	Hydraulic, sluice

Emergency Gates

Number	3
Size	4' x 8'
Type	Hydraulic, sluice
Gate Sill Elevation, ft., msl	575
Maximum discharge of outlet, reservoir at spillway crest c.f.s.	4800
Downstream channel capacity, c.f.s.	3400 (est.)

Stop Gate

Number	1
Size	6' x 12'
Type	Structural Steel

12. Real Estate. (Including lands for relocations)

Total to be acquired, acres	2,021
Classification, Acres	
Metropolitan District	1,656
State Forest	2
Private	
Home sites	14
Open Land	89
Wooded, Waste & River	259
Gravel Pit	<u>3</u>
TOTAL	2,021

Improvements	
Residences with outbuildings	6
Machine Shed	1

13. Relocations.

Roads	
Highways, to be abandoned	6.0 miles
Highways, to be constructed	6.9 miles
Utilities	
Power and telephone	6.9 miles
Cemetery	
No. of Graves	75 to 100

14. Principal Quantities.

Unclassified Excavation	150,000 c.y.
Borrow Excavation	700,000 c.y.
Rock Excavation, Open Cut	900,000 c.y.
Rock Excavation, Tunnel	4,700 c.y.
Embankment	
Rolled Embankment	1,700,000 c.y.
Rock Fill	1,100,000 c.y.
Rock Slope Protection	20,000 c.y.
Concrete	13,500 c.y.
Cement	20,000 bbl.

2,820,000

15. Estimated Project Cost.

Lands and Damages	\$ 225,000
Relocations	5,250,000
Reservoir	130,000
Dam and Appurtenant Structures	7,400,000
Road and Bridge	135,000
Recreation	50,000
Buildings, Grounds & Utilities	90,000
Permanent Operating Equipment	40,000
Engineering and Design	935,000
Supervision and Administration	<u>745,000</u>

TOTAL \$15,000,000

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASS.

FLOOD CONTROL PROJECT

COLEBROOK RIVER DAM AND RESERVOIR
WEST BRANCH FARMINGTON RIVER
CONNECTICUT RIVER BASIN
CONNECTICUT AND MASSACHUSETTS

DESIGN MEMORANDUM NO. 6

GENERAL DESIGN MEMORANDUM

REVISED

JANUARY 1965

B. INTRODUCTION

1. Purpose. - The purpose of this memorandum is to furnish information, to present the general plan for the Colebrook River Dam and Reservoir Project, and to facilitate the preparation and review of detailed design memoranda, plans and specifications. This design memorandum supersedes the General Design Memorandum originally submitted in March 1964 and approved on 4 June 1964. Extensive revisions included herein are for the purpose of securing final approval of raising the spillway crest 5 feet to provide a conservation pool for fish and wildlife as a full project purpose (see Paragraph 9 for background information).

2. Scope. - This memorandum presents general data for the entire project on the components, functions, costs and benefits of the Colebrook River Dam and Reservoir Project. The data contained herein will be supplemented and expanded, as required, by supplement to this memorandum and by subsequent design memoranda.

C. PROJECT AUTHORIZATION

3. Authorization. - The Colebrook River Project was authorized by the Flood Control Act approved 14 July 1960, Public Law 86-645, which reads in part as follows:

"The plan for flood control and related purposes on the Farmington River, Connecticut and Massachusetts, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document No. 443, Eighty-sixth Congress, Second Session, at an estimated cost of \$12,052,000."

In House Document No. 443, the Chief of Engineers recommended the construction of a dam and reservoir at the Colebrook River site for flood control and water supply purposes at an estimated construction cost of \$11,280,000 (exclusive of preauthorization studies) provided local interests agree, prior to construction, to repay the United States all allocated costs of water supply storage, presently estimated at \$4,300,000. Provision was made for a single purpose flood control reservoir with minimum provision to permit possible future enlargement of the project for water supply, should local interests not wish to participate in the dual-purpose project.

The provision of 5,000 acre-feet of conservation storage for fish and wildlife improvement is authorized by the Fish and Wildlife Coordination Act approved 12 August 1958, Public Law 85-624, which reads in part as follows:

"(c) Federal agencies authorized to construct or operate water-control projects are hereby authorized to modify or add to the structures and operations of such projects, the construction of which has not been substantially completed on the date of enactment of the Fish and Wildlife Coordination Act, and to acquire lands in accordance with section 3 of this Act, in order to accommodate the means and measures for such conservation of wildlife resources as an integral part of such projects: Provided, That for projects authorized by a specific Act of Congress before the date of enactment of the Fish and Wildlife Coordination Act (1) such modification or land acquisition shall be compatible with the purposes for which the project was authorized; (2) the cost of such modifications or land acquisition, as means and measures to prevent loss of and damage to wildlife resources to the extent justifiable, shall be an integral part of the cost of such projects; and (3) the cost of such modifications or land acquisition for the development or improvement of wildlife resources may be included to the extent justifiable, and an appropriate share of the cost of any project may be allocated for this purpose with a finding as to the part of such allocated cost, if any, to be reimbursed by non-Federal interests."

4. Required Local Cooperation. - No local cooperation is required for the flood control portion of the project. As stated in Paragraph 77 of the project document, "The cost of constructing a single-purpose flood control reservoir at the Colebrook River site should be wholly Federal since the benefits would be largely general in character."

Requirements of local cooperation applicable to the water supply portion of the project are contained in the report of the Chief of Engineers published in the project document. As quoted from the Report of the Board of Engineers for Rivers and Harbors, the requirements are as follows:

"(1) Reimbursement to the United States of that portion of the construction cost allocated to future water supply, amounting to 30

percent of the construction cost of the project, presently estimated at \$3,384,000, plus interest during construction on this amount. This reimbursement shall be made within the life of the project, but in no event shall the repayment period exceed 50 years after the project is first used for future water supply purposes, except that no payment need be made on this amount or interest charged thereon, until storage is first used for future water supply purposes, but in no event shall the interest-free period exceed 10 years;

(2) Payment to the United States of that portion of the construction cost allocated to water supply for immediate use, amounting to 8 percent of the construction cost of the project, presently estimated at \$908,000, such payment to be made either at the time of construction of the project or on an annual basis within a period of 50 years, provided that such annual payments shall begin when the project is first available for storage of water for any purpose and shall provide for repayment of the principal, plus interest thereon during construction, and interest on any unpaid portion of the total amount;

(3) Payment to the United States of the portion of the costs for maintenance and operation of the project, allocated to water supply for immediate use after the project is first used for any purpose, amounting to 8 percent of the total annual project cost for maintenance and operation, presently estimated at \$2,160 annually; and in addition, that portion of the costs for maintenance and operation of the project allocated to future water supply, after such water supply is first used, amounting to 30 percent of the total annual project costs for maintenance and operation presently estimated at \$8,100 annually;"

The Chief of Engineers concurred with the above recommendation except that, "with regard to the portion of the construction cost of the Colebrook project allocated to water supply for immediate use, presently estimated at \$908,000", he recommended, "that payment to the United States be made either at the time of construction of the project or on an annual basis within a period of 50 years, provided that such annual payment shall begin when the project is first available for storage of water for water supply purposes and shall provide for repayment of the principal, plus interest thereon during construction, and interest on any unpaid portion of the total amount."

Section 3(b) of the Fish and Wildlife Coordination Act, Public Law 85-624, provides that waters and other interests for wildlife conservation purposes, other than migratory birds, shall be made available without cost for administration by the head of the agency exercising the administration of the wildlife resources of the State. Accordingly, the provision of necessary water rights for storage and release of water for the fisheries pools is the responsibility of the State of Connecticut. In addition, the construction of a proposed fishway at a downstream dam is also a State responsibility.

D. SELECTION OF SITE

5. Selection of Site. - There is an urgent need for flood control storage to afford the communities of Riverton, New Hartford, Collinsville, Unionville, Farmington, Simsbury, Tarrifville, and Rainbow, Connecticut, a reasonable degree of flood protection, and to provide additional protection in the lower reaches of the Connecticut River. The Colebrook River site is the most desirable site for flood control storage for the main stem of the Farmington River. Alternate sites in the basin were considered for the Interim Report (see Paragraph 6). Alternate sites in the Colebrook River area are discussed in Paragraph 17b and in Design Memorandum No. 1, "Site Selection", dated 13 March 1963.

The site permits additional development of the Farmington River for water supply purposes. The water supply storage, together with a possible diversion tunnel from the Goodwin Dam to Barkhamsted Reservoir will permit substantially complete development of the West Branch Farmington River watershed for water supply.

E. INVESTIGATIONS

6. Previous Investigations. - An Interim Report on Review of Survey, Farmington River Basin, was submitted in December 1958 and published without appendices in House Document No. 443, 86th Congress, 2nd Session. The preparation of the report was authorized by resolution of the Committee on Public Works of the United States Senate on 14 September 1955. The report provided for the construction of a flood control and water supply reservoir of 81,500 acre-feet capacity. The flood control capacity, of 50,800 acre-feet, is equal to 8 inches of runoff. The 30,700 acre-feet of water supply capacity is equal to 10 billion gallons. The site was located on the West Branch Farmington River about 3.3 miles above its confluence with the Still River with spillway at Elevation 747.0 m.s.l.

7. Prior Reports. - Flood control on the Farmington River and its tributaries has been considered in the following published reports on the Connecticut River Basin:

<u>House</u> <u>Doc. No.</u>	<u>Congress</u>	<u>Session</u>	<u>Date</u>	<u>Remarks</u>
412	74th	2nd	1936	Survey Report. Presented general plan for improvement of Connecticut River and tributaries. Recommended initial plan of 10 flood control reservoirs in Vermont and New Hampshire.

<u>House Doc. No.</u>	<u>Congress</u>	<u>Session</u>	<u>Date</u>	<u>Remarks</u>
455	75th	2nd	1937	Survey Report. Proposed comprehensive plan of dikes and 20 reservoirs for flood control on the Connecticut River.
653	76th	3rd	1940	First Interim Review Report on the Connecticut River. Recommended modification of authorized project for protection by dikes and related works.
724	76th	3rd	1940	Second Interim Review Report on the Connecticut River. Recommended additional local works and 20 reservoirs for flood control with adaptations for future development of power. Local protection consisting of channel improvement and dam removal at Winsted was recommended.
137	87th	1st	1957	Interim Report on Mad River, Farmington River Basin, Connecticut. The construction of Mad River Dam on the Mad River upstream of Winsted, Connecticut was recommended.

8. Current Investigations. - Studies for the project plan utilized the basic data obtained for the previous investigations. Hydrologic studies were made to review the recommended reservoir capacity and to determine the spillway design flood. Consideration was given to additional storage for water supply purposes and for low flow augmentation for the downstream fishery and water quality control. Aerial photogrammetry was obtained and a preliminary survey for a possible chute spillway and a base line profile at the upstream site were made. Detailed surveys and geological studies of the report site were made and potential sources of borrow material were investigated. Comparative estimates for both sites were made and Design Memorandum recommending the upstream site was submitted and approved. Detailed surveys and subsurface explorations were made. Relocations of State Highways have been discussed with the State Highway Departments and preliminary estimates prepared. Relocations of utilities have been discussed with the owners and preliminary estimates prepared.

There is currently underway a comprehensive river basin study for the Farmington River Basin. This study is being accomplished by the Travelers Research Center under contract with the Connecticut Water Resources Commission. The study is being funded in part by State appropriations and in part by private grants obtained by the Farmington River

Watershed Association and is scheduled for completion in January 1965. The Farmington River Watershed Association has sought to delay planning of the Colebrook River project until completion of the study. Legislation which would have required the Connecticut Development Commission to request the Corps of Engineers to delay planning and construction of the Colebrook River Dam to allow state agencies affected by the project to make surveys was defeated in the 1963 session of the Legislature.

It is considered, on the basis of the data in the Interim Report, that the Colebrook River project will be an essential unit in any new comprehensive plan which may be developed for the Farmington River. It is further considered that the flows being developed for water supply storage and fishery improvement represent the maximum obtainable within economic limitations under current and prospective water allocations. Planning on the project is therefore being completed with the concurrence of the Water Resources Commission of the State of Connecticut.

9. Addition of Fish and Wildlife as a Project Purpose. - As authorized, the project included only flood control and water supply as project purposes. Early in the planning stage, consideration was given to adding storage for low flow regulation desired by local interests, particularly the Farmington River Watershed Association. At that time, it was evident that flows in excess of 150 c.f.s. and also in excess of water supply storage capacity would be insufficient to provide for dependable operation unless provision were made for carry over from year to year. Use of flows from 50 to 150 c.f.s. was indicated as a possibility, but no action was taken by the local interests to effect this. In authorizing construction of the Goodwin Dam, the State had provided for the passage of flows up to 150 c.f.s. without storage at this dam.

After much discussion, a tentative compromise was reached, whereby, as a mitigation measure, the Metropolitan District agreed they would maintain a holdover pool after substantial quantities of water are diverted.

The Fish and Wildlife Service accepted this compromise, but the Farmington River Watershed Association and Connecticut Board of Fisheries and Game did not concur. The Farmington River Watershed Association then prepared a lengthy criticism indicating that control of 5,000 acre-feet of new storage would provide for a new 30,000 man-day-per-year fishery. The Fish and Wildlife Service was asked to comment and did so on 1 June 1964. They indicated fish and wildlife benefits of \$84,000 per year could be realized by seasonal use of part of the flood control storage and by the provision of 5,000 acre-feet of additional storage. This benefit justified raising the dam.

Based on this reply and additional supporting information forwarded on 16 July and 1 September, the Chief of Engineers approved fish and wildlife as a primary project purpose on 2 October 1964. This approval was based on the understanding that the State of Connecticut,

through its Department of Agriculture and Natural Resources, will actively pursue the steps necessary to acquire the required water rights and the modification of existing downstream facilities where required and that in any event this additional storage is incrementally justified. Progress in this respect and justification is presented in Paragraphs 63d and e, 85 b, and Exhibits 4 and 5.

10. Public Hearings. -

a. Formal Meetings. A public hearing was held in Unionville, Connecticut, on 18 December 1956 to obtain the views of interested parties with respect to flood control and allied measures on the Farmington River, Connecticut and Massachusetts. The hearing was attended by approximately 94 persons, including representatives of the U. S. Bureau of Public Roads, the U. S. Geological Survey; the Corps of Engineers; the State of Connecticut; the Cities of Hartford, and Winsted; the Towns of Avon, Barkhamsted, Canton, Colebrook, East Granby, Farmington, New Hartford, Plainville, Simsbury, Winchester, and Windsor; manufacturing and business establishments; railroads and public utilities; agricultural and recreational interests; newspapermen; and interested private organizations and individuals. Improvements requested included flood control dams and reservoirs, dikes, bank protection, channel improvements, and other improvements. Consideration of water supply and recreation was requested. There was no preponderance of local opinion for any one or more of the specific desires expressed at the hearing, although the majority of proposals expressed were for various local channel clearance or straightening projects at numerous points throughout the watershed. A digest of the public hearing and of letters from interested parties relative to the hearing is included in Appendix A of the Interim Report.

An open public meeting was held by the Farmington River Watershed Association on 23 March 1960. About 250 persons including representatives of interested public agencies were in attendance to hear a description of the Farmington River projects and comments by representatives of interested agencies.

On 17 June 1960, the Colebrook River Dam project was described at a meeting of the Colebrook River Taxpayers Association. About 100 persons were present. There were two fields of concern to the residents. One involved the land which might be taken out of taxation through Federal ownership. The second was the possibility that Route 8 might be relocated up the Sandy Brook Valley which would isolate some residents of New Boston and Colebrook.

A public hearing was held by the Connecticut State Highway Department on 17 October 1963 in regard to the relocation of Route 8. There was no opposition to the highway relocation and some favorable expression of opinion that the highway relocation proposed was more suitable than an alternate alignment in the Sandy Brook valley.

Information concerning the project in general was furnished in response to questions from the floor. No opposition to the Colebrook River project was specifically expressed. The 1st Selectman of Colebrook did, however, ask what could be done if the people decided they did not want the project. He was advised that they should go back to Congress which authorized the project.

A public hearing was held by the Massachusetts Department of Public Works on 26 March 1964 in regard to the relocation of Route 8. Two alternate locations, a westerly location and an easterly location were presented. The westerly location would remain west of the West Branch, Farmington River and would eliminate two sharp bends at New Boston. Requests were made for consideration of connections for Clark Road, Thorpe Road and Roberts Road. These are barely passable woods roads. Request for connection to the old Route 8 was made and entered on the record. Discussion centered on the relative advisability of the two roadways. No opposition to relocation or to the Colebrook River Project was expressed. Information regarding the holdover pool (see Paragraph 63) and public access for hunting, fishing, and boating in Connecticut was given in response to questions from the floor.

A real estate meeting sponsored jointly by the Water Resources Commissions of Connecticut and Massachusetts and the Corps of Engineers was held in the Sandisfield Town Hall on 21 October 1964. The project plan and real estate procedures were described. Inquiry was made as to whether the Allied Connecticut Towns would be compensated for loss of the guaranteed 50 c.f.s. while the West Branch Reservoir was dewatered. It was stated that the dewatering would not interfere with the basic riparian right to the free natural flow of the river. No objection to the project or to the provision of fishery conservation pools was expressed at the meeting.

A Farmington Valley Water Resources Planning Conference was conducted by the Farmington River Watershed Association and the Travelers Research Center on 4 December 1964. Representatives of the Travelers Research Center indicated that the Colebrook River Dam is the most economical way of protecting major flood damage centers on the main stem and West Branch of the Farmington River. As presently prepared, their preliminary overall plans for the valley include the Colebrook River project for flood control, water supply and fish and wildlife. No opposition to the project or any of its purposes was indicated by any of the approximately 100 representatives in attendance at the meeting.

b. Other Meetings. To the date of this memorandum, numerous informal meetings and contacts have taken place with Federal, State and local agencies. Prominent meetings were held on 7 and 27 June 1962, 2 November 1962, 17 and 18 October 1963, 15 November 1963, and 26 February 1964. Attendance at these and other working meetings has included representatives of the Federal Fish and Wildlife Service and Department of Health, Education and Welfare, the Connecticut Water Resources Commission, Park and Forest Commission, Board of Fisheries and Game and

Health Department; the Massachusetts Water Resources Commission; the Metropolitan District and the Farmington River Watershed Association, the Travelers Research Center, the Collins Company and the Farmington River Power Company. Meetings in regard to relocation of Route 8 were also held with representatives of the Massachusetts Department of Public Works and Connecticut State Highway Department.

F. LOCAL COOPERATION

11. Local Cooperation. - No local cooperation is required for the flood control portion of the project. Requirements of local cooperation applicable to water supply are quoted in Paragraph 4. The Metropolitan District of Hartford has continued its interest in the project and furnished assurances of its local cooperation in the water supply portion of the project. In the November 1962 election, the voters of the District approved the appropriation of \$6,000,000 for the District's share of the cost. Legislation to empower the Metropolitan District to enter into an agreement with the United States in connection with the project and to divert further water from the West Branch of the Farmington River was enacted by the State of Connecticut on 6 June 1963. As indicated in Paragraph 66, the cost of the water supply storage is presently estimated to be \$5,336,000. Prospects for continued local cooperation are excellent. Mr. William A. D. Wurts, District Manager, the Metropolitan District, 115 Broad Street, Hartford, Connecticut, is the principal official with whom local cooperation has been discussed and to whom correspondence has been directed.

Local cooperation will be required to furnish necessary water and water rights for dependable operation of the fisheries pools. This is discussed further in Paragraph 63.

G. LOCATION OF PROJECT AND TRIBUTARY AREA

12. Location of Dam and Reservoir. - The Colebrook River Dam site is located in northwestern Connecticut, in the Town of Colebrook. It is on the West Branch Farmington River about halfway between the Village of Riverton and the former Village of Colebrook River, from which the project derives its name. Colebrook River Village was vacated because of being within the West Branch Reservoir formed by the Goodwin Water Supply Dam, owned by the Metropolitan District of Hartford, and the project site also lies within this pool. The Colebrook River Reservoir will extend into the Towns of Tolland and Sandisfield in Hampden and Berkshire Counties in the southwestern part of Massachusetts.

The relation of the proposed dam and reservoir with respect to the Farmington River Basin and to other flood control projects in the Farmington River Basin is shown on Plate No. 6-1. The reservoir map is shown as Plate Nos. 6-3 and 6-4.

13. Description of the Farmington River Basin. - The Farmington River Basin, the fourth largest sub-basin of the Connecticut River system, is located in southwestern Massachusetts and north-central Connecticut, within the confines of Berkshire and Hampden Counties in Massachusetts, and Litchfield and Hartford Counties in Connecticut. The Farmington Watershed has a maximum length of 46 miles, a maximum width of 29 miles, and a total drainage area of 602 square miles. The West Branch is one of its major tributaries.

14. West Branch Farmington River. - The West Branch Farmington River rises in Shaw Pond on the Otis-Becket, Massachusetts, town line and flows in a general southerly direction for about 33 miles to its confluence with the East Branch in New Hartford, Connecticut, below the dam site. The portion of the basin above Riverton is bounded on the southwest by the Still River and Sandy Brook watershed, and on the east by the East Branch watershed, all within the Farmington River Basin. It is bounded on the west by portions of the Housatonic River watershed and on the northeast by portions of the Westfield River watershed, which is also tributary to the Connecticut River. The West Branch Basin above Riverton is irregular in shape, with a maximum length in a general north-south direction of about 22 miles and a maximum width in an east-west direction of about 9 miles. The river falls about 780 feet from its source at Shaw Pond to the project site in a distance of about 19 miles. The watershed is quite hilly, with scattered swamps and ponds in some of the valleys. The only large body of water within the watershed is Otis Reservoir with a drainage area of 17.2 square miles. The area is rural and sparsely settled, with the hills and most of the valleys covered by dense woods. The drainage area is shown on Plate No. 6-2.

H. RECOMMENDED PROJECT PLAN

15. Recommended Project Plan. - The recommended project plan for the Colebrook River Dam and Reservoir includes the construction of (1) a rolled earth and rock fill dam on the West Branch, Farmington River about 3.9 miles above its confluence with the Still River, (2) an outlet works consisting of a control tower on rock and a tunnel in rock in the north-east abutment, (3) an ogee chute type spillway in the north-east abutment, (4) a dike in a saddle south-west of the dam between the reservoir and the Still River watershed, and (5) relocation of Route 8 in the States of Connecticut and Massachusetts.

I. DEPARTURES FROM PROJECT DOCUMENT PLAN AND APPROVED GENERAL DESIGN MEMORANDUM

16. Project Document Plan. - The Colebrook River project was authorized under the Flood Control Act of 14 July 1960 substantially in accordance with the recommendations of the Chief of Engineers in House Document No. 443, 86th Congress, 2nd Session. This plan proposed flood control storage of 50,800 acre-feet, equivalent to 8 inches

of runoff from the tributary drainage area of 119 square miles and water supply storage of 30,700 acre-feet, equivalent to 10 billion gallons. From the available U.S.G.S. quadrangle sheets, this capacity set the spillway crest elevation at 747 feet, mean sea level. The total authorized storage capacity is 81,500 acre-feet above the elevation of the West Branch Reservoir.

17. Departures from Project Document Plan. - The following modifications and changes from the project document plan have been made during the development of detailed studies based on additional investigations and information obtained.

a. Area-capacity curves developed from the new photogrammetric maps of the reservoir indicated that to obtain the authorized total storage of 81,500 acre-feet above the elevation of the West Branch Reservoir, the spillway crest elevation would have to be at 749 feet, mean sea level.

b. The site was moved 3100 feet upstream. As indicated in Design Memorandum No. 1, Site Selection, large deposits of talus on the abutments and a near vertical and partly overhanging cliff on the interim report site led to selection of the present site. This reduced the drainage area to 118 square miles and required a further increase in spillway crest elevation to 756, mean sea level. See Area-Capacity Curves, Plate No. 6-13.

c. Results of economic studies based on surcharges versus spillway lengths indicate that a 24-foot surcharge with a chute-type spillway is comparable in cost to a side channel spillway. The chute type is considered preferable and was adopted.

d. The dike was moved approximately 1600 feet southwestward to the watershed divide. It was learned that future plans of the State of Connecticut provide for reconstruction of Route 8 south of the project. It was considered advisable to eliminate the diversion of flow from the area between the two dike sites into another watershed.

e. A 10-foot diameter tunnel was substituted for the 10-foot diameter conduit. With the approximate 210-foot embankment loading on the conduit, a tunnel was found to be more appropriate and economical than a conduit.

f. Six thousand (6000) acre-feet of storage were added. Five thousand (5000) of this, equivalent to 1.629 billion gallons were added in accordance with the recommendations of the Fish and Wildlife Service. The remaining one thousand (1000) resulted from rounding off the spillway crest elevation to the next even foot, a total increase of 5 feet, and is reserved for dead storage and sedimentation.

g. Boat launching ramps and parking areas were added to provide for fishermen and for general recreation.

18. Departures from Approved General Design Memorandum. - The following modifications and changes from the plan as presented in the General Design Memorandum, dated March 1964 and approved on 4 June 1964, have been made.

a. Fish and Wildlife has been added as a primary project purpose under the authority of Public Law 85-624 of the Fish and Wildlife Coordination Act. This required raising the dam by 5 feet to provide 5,000 acre-feet of conservation storage for the downstream fishery. This fishery conservation storage has been designated as "Pool c".

b. Operational plans were modified to provide for the joint use of 5,000 acre-feet of storage for flood control and the downstream fishery. This storage has been designated as "Pool b".

c. Other changes and specific references to the above modifications are tabulated below:

(1) Section A, Pertinent Data, was revised to provide for the added height of dam and other changes.

(2) Paragraphs 1, 3, and 4 were expanded to cover the fishery purpose.

(3) In paragraph 8, the last unnumbered paragraph was revised.

(4) Paragraph 9 was added to provide background information on fish and wildlife as a primary project purpose. Subsequent paragraphs have been renumbered. References which follow are to the revised numbers.

(5) Paragraph 10 was expanded to include meetings of 21 October and 4 December 1964.

(6) Paragraph 11 was expanded to indicate required local cooperation for operation of fisheries pools. Present estimated cost of water supply storage was revised.

(7) Paragraph 12 was expanded to show the derivation of the project name from the former Village of Colebrook River which was vacated.

(8) In paragraph 17, Sub-paragraph 17f was deleted and was replaced by the reference to the higher dam for the fisheries pool. The wording of Sub-paragraph 17g was revised.

(9) In Section I and Paragraph 18, the section title was changed and Paragraph 18 was added.

(10) Elevations were changed in Paragraphs 19, 21, and 22.

(11) Paragraph 26 was revised.

(12) Minor revisions were made in Paragraphs 32 to 36 inclusive because of the added dam height, to widen the top of dam and because the embankment design has been completed.

(13) Paragraph 37 was revised. The principal change was to substitute a monorail hoist for the crane, lowering the height of the superstructure. The description of the tunnel was expanded to include contact grouting and rock support and other minor changes were made.

(14) The next to the last unnumbered sub-paragraph in paragraph 38 was rewritten to indicate that the West Branch Reservoir will be allowed to fill if it becomes evident that the embankment will be overtopped. In the last sub-paragraph, a fourth season was added.

(15) Paragraph 39 was rewritten.

(16) A definite statement that operator's quarters will be constructed was added to Paragraph 41.

(17) Paragraph 42 was revised to add 10 feet to the utility building and eliminate the separate comfort station.

(18) Section O, Paragraphs 51 and 52 were rewritten.

(19) Section P, Paragraphs 54 and 55 were rewritten. Paragraphs 56 and 58 were revised to agree with the Real Estate Design Memorandum.

(20) Section Q, minor changes were made in sub-paragraphs 59b and 60b.

(21) Section R, Fish and Wildlife Resources, was moved forward in the outline and rewritten.

(22) Section S, Cost Estimates, was revised.

(23) Section T, Cost Allocation, was revised.

(24) Section U, Schedules for Design and Construction, was revised to conform to present design requirements and to provide for construction of operator's quarters and utility building under a separate contract.

(25) Section V, Reservoir Regulation, was revised. Paragraph 75 was changed because of the provision of the fishery pool and Paragraph 76 revised. Paragraph 77 was added to refer to regulation of the fisheries pools.

(26) Section W was revised. Paragraph 78 was expanded to show that basic recreational facilities will be maintained and operated by the states. Paragraph 79 was expanded and the revised operation and maintenance cost was indicated in Paragraph 81.

(27) Paragraph 82 was expanded to show that the Regional Office of the Department of Health, Education and Welfare has no additional comments at this time.

(28) Beginning with Section Y, the design memorandum was almost completely rewritten.

(29) Appendices A and B were added to include comments by Federal, State and local agencies and show the cost allocation.

J. HYDROLOGY

19. Spillway Design Flood. - The spillway design storm was based on the estimated probable maximum precipitation over the 118 square miles drainage area. The total depth of rainfall over the West Branch Farmington River watershed upstream of Colebrook River Dam was 23.7 inches. Losses including infiltration, were assumed at a maximum rate of 0.20 inches per three hours producing rainfall excess of 21.2 inches. The rainfall excess values were applied to three hour unit hydrographs developed for Otis Reservoir, D. A. = 17.2 square miles, and Colebrook River Reservoir. The inflow hydrograph at Otis Reservoir was routed through the reservoir surcharge storage, assuming the reservoir initially full to spillway crest and the outlet gates operable and open at the time of maximum surcharge. The outflow hydrograph from Otis Reservoir was added directly to the West Branch hydrograph at Colebrook River Reservoir. The peak of the composite spillway design inflow flood hydrograph is 165,000 c.f.s., of which 158,000 c.f.s. is produced by the 101 square miles of uncontrolled drainage area between Otis Reservoir and the Colebrook River Dam site. Routing of the spillway design flood through the Colebrook River surcharge storage, assuming the gates operative, resulted in a maximum discharge over the 205-foot spillway of 92,000 cfs. The pool attained a maximum surcharge elevation of 785 feet m.s.l. or 24 feet above spillway crest, elevation 761 feet, m.s.l.

20. Channel Capacity. - Colebrook River Reservoir will discharge flows directly into the pool of Goodwin Dam. The estimated channel capacity of the West Branch Farmington River below the Goodwin Dam and above the confluence with the Still River is about 3,400 c.f.s.

21. Outlet Tunnel. - The 10-foot diameter outlet tunnel has sufficient capacity to discharge 3,400 cfs with the pool at elevation 701 feet m.s.l., equivalent to the top of the water supply storage with tailwater at approximately elevation 642. The discharge capacity will also satisfy diversion requirements.

22. Freeboard. - The top of dam will be at elevation 790 feet mean sea level which will provide a minimum freeboard of 5 feet above the maximum spillway design surcharge at elevation 785 feet, mean sea level.

K. GEOLOGY

23. General. - The West Branch of the Farmington River lies within the Western Highlands of Connecticut, a rugged, mature region of moderate relief underlain by crystalline rocks. The topography has been modified by glaciation. Broad, rough-crested ridges and irregular hills rise very steeply from the narrow valleys. The region is generally thinly blanketed by till and the main valleys are deeply filled with outwash materials which form wide, flat valley plains and prominent terraces along the valley sides. Bedrock outcrops through the thin till cover in numerous and extensive areas on some of the very steep slopes and along the tops of the hills. The bedrock consists of Paleozoic gneiss and schist with local areas of granite.

24. Foundation Exploration. - Two borings and one test pit were completed at the site in January 1963 to assist in its evaluation for comparison with the downstream site previously investigated for the Interim Survey Report. Results of these investigations were presented in Design Memorandum No. 1, "Site Selection", dated 13 March 1963. Upon approval of the upstream site, a comprehensive foundation exploration program was initiated to obtain information for final design. The layout of the explorations for the dam and structures is shown on Plate No. 6-14. Rock core recoveries and graphic results of pressure tests in explorations made on the centerline of dam embankment and on the alignment of the tunnel are shown on Plates No. 6-15 and 6-16 respectively.

25. Site Geology. -

a. Dam. - A terrace composed of sands and gravels ranging in thickness from 15 feet to 30 feet occurs along the bottom of the right abutment. Above the terrace the abutment is thinly blanketed by till with numerous boulders. Bedrock outcrops through the thin till cover at scattered locations on the higher part of the abutment and in extensive areas above the top of dam. The left abutment is largely exposed bedrock with nominal overburden consisting of silty, gravelly sand which occurs as filling in troughs between the prominent rock ribs. A deep gully in the rock paved with boulders and large rock blocks extends up the left abutment immediately downstream from the centerline of the dam. The valley bottom is filled to depths of 40 feet or more with variable sands and gravels.

Bedrock consists mainly of gneiss with extensive areas of pegmatitic granite. The gneiss is generally schistose grading locally to typical schist, but in many areas it is quite granitic. The rock is moderately hard and fresh below the normal surface weathered zone. Foliation in the rock is well developed and trends generally N 40° to 50° E with very steep westward dips. The relationship between the bedrock structure and the alignment of the spillway channel and outlet tunnel is favorable and should assist materially in control of overbreak and obtaining stable slopes. Preliminary studies indicate that no unusual difficulties will be encountered in structure foundations, tunnelling or rock excavations.

b. Dike. - Explorations at the dike site show the bottom of the saddle to be deeply filled with outwash deposits consisting of variable sands and gravels. The dike is located on a low ridge composed of outwash which extends across the saddle and is breached by the highway cut for Route 8. Shallow organic deposits occur in the swamps which occupy the bottom of the saddle on both sides of the low ridge near both abutments. Bedrock outcrops upstream from the dike on the west side of the valley, but is deeply buried in the dike foundation.

L. OTHER PLANS INVESTIGATED

26. Additional Storage. - Consideration was given to the possibility of increasing the water supply storage to meet future needs. The Metropolitan District gave this consideration and confirmed the choice of 10 billion gallons. This storage, with the diversion tunnel, from Goodwin Dam to Barkhamsted Reservoir, will fully develop the flow available for storage for water supply in most years as determined from a study of past records. Additional storage would result in decreasing increments of yield and is considered uneconomical. Additional storage has been provided for fish and wildlife purposes as discussed in Paragraph 63.

27. Alternate Sites. - Consideration of the amount of talus existing in the foundation at the Interim Report site indicated that an alternate site located 3,100 feet upstream might be more feasible. Detailed studies of both sites led to the conclusion that the upstream site, despite greater above ground embankment volume, is definitely more economic. Selection of site is discussed in detail in Design Memorandum No. 1, Site Selection, approved 11 April 1963.

28. Type of Dam. - A gravity concrete dam at either the Interim Report site or the recommended site would be more costly than the recommended plan. Other types of concrete dams, particularly the arch dam were considered. No savings were indicated and it is considered that the cost of extended investigations to determine the suitability of the foundation is unwarranted. The site is in many respects similar to that at Ball Mountain, where, after extensive studies and consultations, a concrete arch was rejected in favor of an earth dam.

29. Type of Spillway. - Comparative estimates indicate that the chute type spillway is comparable in cost to the side channel spillway. As the chute type is considered preferable, it was adopted.

30. Spillway Length vs. Surcharge. - Comparisons of cost for various spillway lengths and surcharges indicated that the economic length of spillway is 205 feet with a corresponding surcharge of 24 feet.

M. DESCRIPTION OF PROPOSED STRUCTURES AND IMPROVEMENTS

31. General. - The Colebrook River Dam and Reservoir Project will consist of a rolled earth and rockfill dam, a rolled earthfill dike in the watershed divide west of the dam, a chute type spillway in the north-east dam abutment and outlet works consisting of a control tower, service bridge and concrete lined tunnel in rock under the north-east dam abutment. General plan of the dam is shown on Plate No. 6-5.

32. Dam. - The project plan provides for construction of a rolled earth and rockfill dam approximately 1300 feet long with a maximum height of about 223 feet above streambed at centerline of dam. The crest will be 30 feet wide accommodating a paved access road. Guard rails will be provided as the roadway will be used for access to the control tower. The top elevation of the dam will be 790.0 mean sea level providing for 24 feet of spillway surcharge and 5.0 feet of freeboard. The embankment slopes will be 1 on 2, except that the top 10 feet will be steepened to 1 on 1-3/4 to allow for the 30-foot top width. Inasmuch as the dam is relatively high and the valley narrow with steep abutments, the dam will be curved in plan upstream on the assumption that axial compression in the dam will be beneficial in maintaining contact with the abutments and in reducing the possibility of cracking.

The dam embankment section will be of the zoned type and will include zones of rockfill, impervious, and pervious embankment materials, the locations, compositions and dimensions of which are shown on Plate No. 6-6. The zonation of the embankment has been established on the basis of the availability and characteristics of the various types of materials. A foundation cutoff will be provided to extend the impervious fill section to bedrock which will be grouted. Drainage features are incorporated in the embankment section as required for adequate control of seepage. The profile of the dam and grouting details are shown on Plate No. 6-7.

33. Dam Embankment Design. - The dam embankment design is influenced by foundation conditions and the availability and characteristics of embankment materials. Earth embankment materials available from required excavations are expected to furnish only a minor portion of the embankment materials for the dam. Details of the embankment design are included in the design memorandum on embankments and foundations approved 24 July 1964.

Seepage through the embankment will be controlled by the embankment zonation while seepage through the foundation will be controlled by a foundation cutoff.

34. Dike. - A rolled earthfill dike approximately 1240 feet long with a maximum height of about 54 feet at the centerline will be constructed across a saddle about 2,600 feet south-west of the south-west abutment of the dam. The dike embankment will be of the zoned type with rock slope protection, an upstream impervious fill blanket and drainage features. The outer slope will be 1 on 2-1/2. The plan and profile of the dike and embankment section are shown on Plate Nos. 6-8 and 6-9.

35. Dike Embankment Design. - The dike embankment design is influenced by foundation conditions and the availability and characteristics of embankment materials. Details of the embankment are included in the design memorandum on embankments and foundations.

36. Spillway. - The spillway will be of the chute type, located in a rock cut on the north-east abutment. For details, see Plate Nos. 6-10 and 6-11. The weir will be an ogee section, straight in plan and founded on bedrock. The length of the spillway weir will be 205 feet at crest elevation 761 feet mean sea level. The height of the weir above the spillway approach will be 14 feet making the maximum elevation of the approach 747 feet mean sea level at the upstream face. The approach channel will slope toward the reservoir on a one percent grade for drainage. The discharge channel width will vary from 199 feet 50 feet downstream of the weir to 100 feet in a distance of 495 feet. The 100-foot channel width will be maintained for the remaining distance of approximately 300 feet. During spillway discharge the West Branch Reservoir will be full and tailwater will vary from approximately elevation 641 to approximately elevation 650. All suitable rock excavated from the spillway channels will be used in the rockfill sections of the dam and the dike. Excavations will proceed at a rate that will allow the excavated rock to be placed in the embankments with minimum stockpiling.

The approach and discharge channels of the spillway will be separated from the dam by a ridge of unexcavated rock. This ridge will be graded to form the service bridge approach, a turnaround and a parking and overlook area. The sides of the channels will be lined with concrete for about 50 feet at each end of the weir. Except for this, the bottom and sides of the spillway channel will be unlined.

37. Outlet Works. - The outlet works will be located in the north-east abutment and will consist of an inlet channel, a control tower, a tunnel in rock under the dam and an outlet channel. Details of the outlet works are shown on Plate Nos. 6-10 and 6-12.

a. Inlet Channel. - The 27-foot wide and 400-foot long inlet channel will be excavated partly in earth and partly in rock, with bottom elevation at 575 feet, mean sea level. The channel will be curved in plan.

b. Control Tower and Operating House. - The control tower will be located about 350 feet upstream of the centerline of the dam and will be a dry well type structure about 250 feet in height, including the 28-foot high operating house. It will be provided with a service bridge for access. Lightning arresters will be provided for the tower and operating house. The lower part of the structure will contain the gate chamber and three 4-foot wide by 8-foot high rectangular conduits with invert elevation 575 feet mean sea level and controlled by vertical service slide gates. Both service and emergency gates will be provided since access for inspection and maintenance will require unwatering the West Branch Reservoir and the tunnel. The gates will be operated by a central high pressure oil hydraulic system. The base of the structure will be extended upstream to support a platform at elevation 627.0, trash rack bars and stoplog slots. A monorail hoist and stop gate will also be provided.

The control tower will contain three floors, an operating room floor at elevation 790.5, an equipment room above at elevation 804.5 and a heater room below at elevation 777.0. The operating room will contain the high pressure oil-hydraulic system for operation of the gates and a continuous water stage recorder. Emergency generating facilities will be provided by an auxiliary diesel engine generator set located in the equipment room and a high lift monorail hoist will be located near the ceiling. Normally, electric power will be obtained from commercial sources. An elevator will be provided for travel from operating room floor to elevation 627. Ship ladders will be used for access below this level to the gate chamber floor at elevation 591.5. A sump pump will be located in a well in the gate chamber floor.

c. Tunnel. - The tunnel will have a length of about 774 feet with its upstream invert at elevation 575 and the invert at the outlet portal at Elevation 573. Throughout most of its length, the diameter will be 10 feet. The tunnel will be lined with unreinforced concrete from the transition to the centerline of dam. Downstream of the centerline of dam, the lining will be reinforced except that a steel liner will be provided for 20 feet at the portal. A ring of grout holes will be provided under the centerline of dam. Provision will be made for contact grouting and some consolidation grouting to take care of bad zones in rock or excessive leakage. Steel supports will be provided in the transition. In the circular section steel ribs or rock bolts will be provided only where rock conditions are such that they are required.

d. Outlet Channel. - The outlet channel will discharge into the West Branch Reservoir and will normally be submerged. The channel will be about 520 feet long and curved in plan and 26 feet wide excavated in rock and earth. The slope of the channel will be $\frac{1}{2}$ of 1 percent

and will merge with the old river bed. The lower portion of the sides and the bottom of the channel will be lined with concrete for a distance of 40 feet from the outlet portal. A stilling basin is considered unnecessary.

e. Service Bridge. - A service bridge will extend diagonally from near the entrance to the spillway approach channel to the tower. Bridge piers and abutment will be founded on rock.

38. Diversion Plan. - It is proposed to unwater the West Branch Reservoir of the Metropolitan District during construction. Construction might be accomplished by means of very high cofferdams, over 70 feet in height, with the construction programmed according to the annual regulation cycle of the present water supply pool. This would be very costly. In addition to the cost of cofferdams, access roads to the northeast abutment would be required and sources of pervious borrow in the reservoir would be inaccessible.

The West Branch Reservoir storage is presently used for stream regulation for hydroelectric power generation at downstream plants. These have a total gross head of 86 feet. Under a Riparian Agreement, the Metropolitan District is committed to provide regulated flow to compensate these downstream riparian owners for water diverted into the water supply system. If part of the commitment to the riparian owners cannot be met, then compensation may be made in cash or equivalent electric energy. The District is agreeable to unwatering the West Branch Reservoir under an agreement which would provide for reimbursement of their costs. The storage which would be unused during the construction period is about 6.5 billion gallons or 30 percent of the total requirement. At present rates, this storage has an annual value of about \$20,000 per year. Because of possible reuse of some of the storage, possible changes in power rates, possible demand charges at the Collins Co. plant and consideration of plant efficiencies and operation the \$80,000 cost for 4 years has been increased to \$100,000. It is proposed to reimburse the Metropolitan District for its costs incurred as a result of unwatering the West Branch Reservoir. This unwatering has the further advantage that the West Branch Reservoir would act as a retarding basin and produce some immediate flood control benefits in the event of a flood.

After unwatering the West Branch Reservoir, the first phase of the diversion plan will be the completion of the intake channel, the lower parts of the control tower, the tunnel and the outlet channel. The ends of the inlet and outlet channels would be completed last so as to afford protection to the work in the event of high water. Concurrently, the stream will be diverted through a temporary diversion channel and the cutoff trench excavated, grouted and backfilled.

The second phase of the diversion plan will be the construction of cofferdams and diversion of flow through the outlet works. The embankment would then be completed between the cofferdams and brought up level to elevation 635. At elevation 635, a 200-foot gap would be left at one of the abutments and additional embankment placed over the remaining embankment area.

Between the second and third seasons, the West Branch Reservoir will be allowed to fill with spring freshet flow passing through both the tunnel and the embankment gap if it becomes evident that the embankment will be overtopped.

In the third and fourth seasons, the West Branch Reservoir will again be unwatered and the embankment completed.

39. Reservoir Clearing. - It is planned to clear the portion of the reservoir below elevation 718 which is ten feet above the level of the water supply and fishery conservation pools. This elevation provides a freeboard of 3.5 feet above Elevation 714.5, the maximum level of the joint use flood control and fishery conservation pool. The area at elevation 718 is 820 acres of which about 350 are wooded and 400 are in the cleared area of the West Branch Reservoir pool below elevation 650.

Cost of reservoir clearing is considered a specific cost for water supply and fishery conservation. Cost is allocated on the basis of the amount of storage used for each of these purposes.

40. Gages. - Various type gages will be provided at Colebrook River Dam and at key index stations as follows:

a. Tile Gages. - A series of tile gages will be provided for reading reservoir stages.

b. Recording Gages. - Recording gages will be provided to maintain a permanent record of the reservoir and tailwater stages.

c. Radio Gages. - Radio gages will be provided at key index stations on the Farmington and Connecticut Rivers and at Mad River Dam for reservoir regulation purposes.

41. Operator's Quarters. - Operator's quarters will be constructed near the entrance to the dam. Because of the relatively close proximity of the Colebrook River Dam to Winsted, a city of about 8,100 population, the need for constructing operator's quarters at this dam was very carefully considered. Information received from local real estate sources indicates that rentals ranging from \$75.00 to \$100.00 per month are presently available within commuting distance of the dam. It is further noted that access to the dam and appurtenant structures is very good from all directions. Although these facts may tend to alleviate the need for constructing new quarters at the dam, there are, however, a number of other factors in favor of the dam operator living at the site, some of which are indicated below.

a. Prescribed rules of reservoir regulation require the operator to report pool stage whenever one inch of rain occurs. If the operator lives some distance from the dam, it would be difficult to

enforce this and other operational rules during non-working hours. It has been the experience that alerting reports originate 75 percent of time during non-working hours.

b. Normal communications with the operator during working hours and flood periods will be by radio. In addition, it is planned to have this dam as a read out point for a portion of the hydrologic reporting network. Therefore, the radio equipment should be located in the utility building and a mobile installation would be unsuitable. Consequently, it is necessary to have the operator close to the radio at all times.

c. Recording rain gages are normally installed at all dams; however, a rain gage at an unattended dam will be exposed to vandalism and costly repairs.

d. Whenever floods develop on the Farmington River, it will be essential to operate the gates promptly since the project is located above zones of high potential damage. Having the operator living at the site will give the public a greater sense of security. The people downstream will know that there is someone always alert to flood conditions and always available for immediate operation. Experience at other projects has shown that an operator living at the dam develops a certain amount of prestige in the neighborhood and downstream communities. Public officials recognize his responsibilities and often raise general questions concerning storm and flood conditions.

e. The subject of vandalism has been carefully considered. Although the dam is located in the Town of Colebrook, it is not far from the outskirts of Winsted. The immediate vicinity of the dam is undeveloped. With a public highway passing the site, the dam will be readily accessible from all directions. With the attraction provided by the project and the emphasis on public recreation, a large number of visitors may be expected. Although deliberate vandalism on the part of visitors is not expected, nevertheless, experience at other projects demonstrates the need for prudent management. Under these circumstances, it does not appear proper to leave Government property unattended. Good public relations also require that some responsible person or persons should be available for general guidance and assistance to visitors to the dam and recreational facilities. It is therefore believed to be in the best interest of the public and the Government to provide quarters for the operator and his family on the site.

f. The rental rates in Winsted and vicinity appear to be comparable to and perhaps slightly higher than the current minimum rental rates for Government quarters. It is considered that a dam operator's current salary is adequate for him to pay the minimum rental rates to help defray the cost of the quarters.

g. A potential site for an operator's quarters, near the utility building, is particularly favorable at the Colebrook River Dam. By sharing the outside utilities, - water, sewage disposal, and electricity, with the Utility Building, the cost of providing these services for the operator's quarters will probably not exceed \$500. The quarters will be located near a public road with regular mail service and school bus routes. The estimated cost of the quarters, including a garage, is \$19,000 for a 3 bedroom, 1,100 square foot building.

42. Utility Building, Garage and Comfort Station. - A combined utility building, garage and comfort station 32 feet by 75 feet will be constructed near the entrance to the dam. The building will include office, toilet, comfort station, heater room, workshops, and garage facilities.

43. Access Roads and Railroad Facilities. -

a. Access Roads. - Access to the project site will be provided from relocated Route 8 at the west end of the dike. An 18-foot wide bituminous surfaced access road 4,200 feet in length will provide access across the dike and around the south-west abutment to the top of dam. The location of the access road is shown on Plate No. 6-3. The profile is nearly level with longitudinal grades of about $\frac{1}{2}$ percent.

Access to the dam site is also available over existing abandoned roads in the lower part of the reservoir area. These roads will provide access for construction purposes. Additional haul roads will be constructed as necessary.

b. Railroads. - Railroad transportation is available on the New York, New Haven and Hartford Railroad in Torrington and Collinsville, Connecticut. Torrington is on Route 8 about 15 miles from the project site. Collinsville is off Route 44 and is about 17 miles from the project site.

44. Use of Consultants. - The Colebrook River Dam imposes no complex design problems. Technical specialists of the Office of the Chief of Engineers will be called upon for advice as the design progresses to avoid major revisions at a later date.

N. SOURCES OF CONSTRUCTION MATERIALS

45. Impervious Material. - Materials for the impervious sections of the embankment are available in thick and extensive deposits of till which occur on the hill above the dike site on the east side of Route 8. The till is compact, characteristically variable, relatively impervious and consists mainly of well-graded, gravelly, silty sand with cobbles and boulders. Explorations indicate that, throughout most of the area, the till ranges in thickness from approximately 15 feet to more than 65

feet. This area, designated Area C, is approximately 1 mile haul distance from the damsite and is immediately adjacent to the dike site as shown on the Reservoir Map, Plate No. 6-3.

46. Pervious Material. - At and immediately upstream from the damsite extensive deposits of pervious materials occur in the valley bottom and in terraces along the valley sides. Explorations show that these deposits are generally more than 20 feet thick and extend northward in the reservoir for more than 1.5 miles. These outwash deposits consist mainly of stratified and lensed sands and gravels with numerous concentrations of cobbles and generally scattered, but also locally concentrated boulders. This area, Area B, shown on the Reservoir Map, Plate No. 6-3, should provide adequate quantities of material for the pervious fill sections of the dam and dike embankments.

47. Processed Sand. - The small quantity of processed sand required for certain drainage features in the dike embankment will be obtained from commercial sources.

48. Gravel Fill, Gravel Bedding and Road Gravel. - Materials suitably graded for use as gravel fill, gravel bedding and road gravel are selectively available in the pervious deposits in Area B.

49. Rock Fill and Rock Filter. - Rock for rockfill will be obtained from required excavations. The rock is mainly gneiss with schistose and granitic phases. In the schistose, micaceous phases of the rock, slabby, elongated shapes and a high proportion of fines will be produced in blasting and from handling. Where the rock is more granitic, blocky, more durable and cleaner rock will be obtained. Rock for rock filter sections in the dam will be obtained by processing.

50. Concrete Aggregate. - The quantity of concrete required for the structures is approximately 20,000 cubic yards. In view of this relatively small quantity, investigations of sources of aggregate materials have been limited to consideration of established commercial sources within a 30-mile haul distance of the site. Complete results of these investigations are presented in Design Memorandum No. 7, "Concrete Materials," dated 27 September 1963.

O. RESERVOIR MANAGEMENT AND PUBLIC USE

51. General. - The Colebrook River Reservoir is being designed and constructed as a multi-purpose project to include provisions for flood control, present and future water supply storage for the Metropolitan District of Hartford County, Connecticut, and for downstream fishery improvement. It is presently estimated that the first use of water supply storage for domestic purposes will be in the year 1975 or soon thereafter.

Connecticut law prohibits the use of water supply reservoirs for swimming. State law also prescribes that boating, hunting and fishing shall be allowed. Picnicking, as well as swimming, is not considered

as a compatible use of a watershed for a water supply reservoir by the Metropolitan District Commission and therefore these uses are not proposed for the reservoir area. Hunting, fishing, boating, sightseeing and leisurely use will be allowed in the reservoir area.

52. Recreation. - The reservoir area is located in a highly scenic open valley embracing relatively steep, well forested slopes through which the river winds. The reservoir area is relatively unspoiled with only six residential properties having any improvements.

The general reservoir area supports no extensive recreation development. A boat launching area has been developed by the Hogback Recreation Commission to provide access to the water supply pool of the West Branch Reservoir. This boat launch area is located upstream of the proposed Colebrook River Dam and will serve as access to the new impoundment. Since the construction of the Colebrook River Dam will eliminate access to the portion of the West Branch Reservoir downstream of the proposed dam, a new boat launching facility has been included to provide access to this area.

The nearby Tunxis State Forest has facilities for picnicking and is the only developed public park area within a ten-mile radius of the project. The nearest tourist accommodations are in Winsted, Connecticut, approximately ten miles from the project.

Access to the reservoir area and to the water supply pool is good. Parking areas, turn-arounds and boat launching ramps will be provided for fishermen and the general public. These areas can be expanded if warranted by future use.

An overlook area with parking and sanitary facilities will be provided for the visiting public at the dam.

P. REAL ESTATE

53. Area Description. - The area in which the Colebrook River Dam and Reservoir is to be located is very sparsely settled. The Town of Colebrook, Litchfield County, Connecticut, has a population of about 840. Sandisfield in Berkshire County, Massachusetts, has a population of about 540 and Tolland in Hampden County, Massachusetts, has about 100. All three towns are rural residential communities with some farming operations being conducted. Few, if any, of these farm units can be classified as being economical.

The project area consists of a narrow cleared valley flanked by wooded, rocky hills which rise quite sharply. There are three substantial residential properties near the upper limits of the proposed reservoir which fall within the category of rural estates. The fourth property having improvements within the taking lines is a rural residential unit that is within the \$12,000 to \$15,000 price range. The fifth has been abandoned for many years. The sixth is a small week-end camp which can readily be moved.

54. Land Requirements and Proposed Rights. - More than 80% of the lands under consideration for this project are publicly owned by the State of Connecticut or the Metropolitan District. These lands were purchased for the purposes of water storage, forestry and recreation.

It is estimated that fee simple title for the lands required for the project would cost \$5,250,000; this includes \$5,000,000 for replacement of the Goodwin Dam. The acreage requirement, that is, all lands 300' horizontally from the full pool or 5' above spillway crest, whichever is the greater, including highway relocations, is 2,024 acres.

Exceptions to the regulations set forth in EM 405-2-150, dated 1 October 1958, as amended 31 May 1963, Real Estate Planning and Project Authorization, Civil Works Projects, were presented in detail in the Real Estate Design Memorandum No. 4, approved on 4 December 1964.

The proposed taking will be as follows:

(a) All areas required for permanent works and operations to be acquired in fee, subject to a flowage easement to the Metropolitan District said easement to allow operation of the Goodwin Dam upon completion of the Colebrook River project.

(b) A five-year construction easement for borrow purposes to be taken in instances where the borrow areas are within the lands of the above.

(c) Flowage easements will be acquired in lieu of fee over lands of the Metropolitan District and the Connecticut State Forest Department that are required for reservoir purposes. The guide taking line is 790.0 feet, mean sea level, equivalent to top of dam elevation.

(d) The easement estates under which the rights are to be acquired from the Metropolitan District will include provisions for the construction, maintenance and operation by the United States Government of recreational facilities and that such facilities situated in Connecticut may be maintained and operated for the general public by the Metropolitan District, the State Park and Forest Commission, or other appropriate State agency, and those located within the Commonwealth of Massachusetts may be maintained and operated for the general public by the appropriate Massachusetts State agency.

(e) Provisions will be made whereby the rights to be acquired in the lands within the Commonwealth of Massachusetts which are owned by the Metropolitan District will include the right for public boating, hunting and fishing.

(f) Privately-owned lands in the State of Connecticut and the Commonwealth of Massachusetts that are required for the project

will be purchased in fee. The guide taking line for these lands in connection with the reservoir will be 766.0 feet, mean sea level (Spillway Crest 761.0 feet plus 5 feet surcharge). The real estate costs are set forth in detail under paragraph 58.

55. Relocations. - The highways within the State of Connecticut will be relocated by the Connecticut State Highway Department. The section of Route 8 within the Commonwealth of Massachusetts will be relocated by the Department of Public Works of Massachusetts.

The boat landing and its ramp situated within the Hartford Metropolitan District Commission's lands must be relocated. No additional land is needed for this relocation. A cemetery in the Town of Sandisfield, Massachusetts, will have to be relocated.

The land requirements for these relocations will be included in the relocation agreement.

56. Severence Damage. - Under the proposed plan of purchasing in fee to the exterior property bounds where remaining acreages will be left without access severance damages should be relatively minor. However, partial takings cannot entirely be avoided. Two partial takings will leave the rear lands fronting the new Route 8, however, the grade of the frontage in reference to the grade of the proposed highway is not known at this time. Presently, with a general knowledge of individual property bounds, it is estimated that damages of this nature will approximate \$7500.

57. Water Rights, Minerals and Crop Damages. - The only water right noted is that of the Metropolitan District which owns the West Branch Reservoir. Since the Colebrook River storage will be above the present West Branch Reservoir storage, there will be no permanent effect upon the existing rights. The damages created by unwatering the West Branch Reservoir during construction have been included in the estimate of the cost of constructing the dam.

No mineral operations were noted at the time of the field inspection. The landowners will be permitted to harvest crops within the area.

58. Valuation. -

Total Estimated Value of Land (Fee & Easements)	\$90,000
Total Estimated Value of Improvements	\$88,000
Total Estimated Value of Land & Improvements	\$178,000

58. Valuation. - (Cont'd)

Severance	\$ 7,500
Contingencies	10,000
Acquisition Costs	25,000
Resettlement Cost	<u>3,500</u>
	\$224,000
<u>Rounded To:</u>	\$225,000

O. RELOCATIONS

59. Relocations. -

a. Roads. - All of the roads within the reservoir area were abandoned about 1954, when the Goodwin Dam was constructed, with the exception of one State Highway, Route 8, and one town road in Colebrook, Connecticut, Beech Hill Road. The Hartford Metropolitan District acquired all lands abutting the West Branch Reservoir and the roads were officially closed. Some sections of the old roads were left open for travel at a person's own risk. Route 8 and a short section of Beech Hill Road were relocated above the West Branch Reservoir at that time.

Sections of existing Route 8, about 3.3 miles in Connecticut and about 3.2 miles in Massachusetts, will be abandoned and a replacement road constructed, of 3.5 and 3.4 miles respectively, above the Guide Taking Line for the Colebrook River Reservoir.

The portion of Beech Hill Road, below the Guide Taking Line, about 1,500 feet in length, will be abandoned and a new connection constructed to the relocated Route 8.

b. Utilities. -

(1) Electric Distribution Lines. -

(a) The Western Massachusetts Electric Company owns and operates distribution lines in the reservoir area on jointly owned poles along Route 8 in Sandisfield, Massachusetts. Approximately 1.2 miles will be abandoned and removed.

(b) The Connecticut Light and Power Company owns and operates distribution lines in the reservoir area on jointly owned poles along Route 8 in Colebrook, Connecticut. Approximately .4 mile will be relocated to the new Route 8 and approximately 0.1 mile will be abandoned and removed. The relocation will facilitate providing

service to the dam and will serve an existing newly constructed camp which is expected to be moved to a new site. Preliminary estimates indicate that there will be no costs for the relocation.

(2) Telephone Cables and Rural Lines. -

(a) The New England Telephone and Telegraph Company owns and operates cables and rural lines in the reservoir area on solely owned and jointly owned poles along Route 8 in Sandisfield, Massachusetts. Approximately 3.4 miles of pole line will be relocated to the new Route 8.

(b) The Southern New England Telephone Company owns and operates cables and rural lines in the reservoir area on solely owned and jointly owned poles along Route 8 in Colebrook, Connecticut. Approximately 3.5 miles of pole line will be relocated to the new Route 8.

c. Cemeteries. - There is one cemetery, Dubois Cemetery, located within the reservoir area in Sandisfield, Massachusetts. This old cemetery, which is estimated to contain 75 to 100 graves, will be relocated outside the reservoir area.

d. Public Buildings. - There are no public buildings located within the reservoir area.

60. Method of Accomplishment. -

a. Roads. - The Connecticut State Highway Department and the Massachusetts Department of Public Works will design and construct the sections of Route 8 relocation within their respective states under cost reimbursable type contracts, including a connector to Beech Hill Road. The estimated cost of relocating Route 8 with Beech Hill Road connector is \$5,200,000. All proposed road relocations and detailed cost estimates are described in Design Memorandum No. 5, Relocations.

b. Utilities. - The relocations of utilities will be accomplished under negotiated agreements with the owners, namely, the Western Massachusetts Electric Company, the Connecticut Light and Power Company, the New England Telephone and Telegraph Company and the Southern New England Telephone Company. The compensation to the owners will be based on replacement in kind, and will include furnishing engineering services, preparing plans and accomplishment of the required relocations; all of which are subject to approval of the Government. Preliminary estimates of relocation costs of utilities are \$1,400 for electric distribution lines and \$23,000 for telephone cables and rural lines, a rounded total of \$30,000.

c. Cemeteries. - The Dubois Cemetery will be relocated by the Government in accordance with prescribed regulations.

R. FISH AND WILDLIFE RESOURCES

61. Existing Fish and Wildlife Resources in Project Area. - The original Conservation and Development Report on Fish and Wildlife Resources prepared by the Fish and Wildlife Service, included in Appendix A as Exhibit 1, indicates that there is only a minor amount of hunting opportunity in the project area. There is also a small stream fishery in the upstream segment of the reservoir area.

62. Downstream Fishery Resources. - There is a substantial stream fishery in the West Branch and the main stem of the Farmington River which will be affected by the water supply feature of the Colebrook River project. The future construction of a tunnel from Goodwin Dam to Barkhamsted Reservoir will permit the diversion of stored water which would otherwise spill from present reservoirs in the late spring, and pass through this fishery. Prior to construction of the tunnel, there may be some benefit to this fishery resulting from the increases in summer and fall flows provided for riparian requirements. There may also be some further benefit resulting from the fact that the construction of the Colebrook River project will delay the necessity for construction of the tunnel and the subsequent acquisition of riparian rights by some ten years.

63. Fishery Provisions. - Fishery provisions are proposed in accordance with recommendations of the U. S. Fish and Wildlife Service in their original report of February 12, 1964, their report of 1 June 1964 and letters of 27 August and 9 December 1964, included herein as Exhibits 1 through 4 respectively. The reports recommended three fishery pools. Each is of 5,000 acre-feet (1.6 billion gallons) capacity. Sub-paragraphs a, b, and c discuss each of these in detail. The various pools are shown on Plate No. 17.

a. Pool a is the holdover pool of the initial planning concept. It is essentially a permanent pool justified on the basis of mitigation of downstream fishery losses expected to occur as a result of the future diversion of water into the Metropolitan District system. These losses will not occur until after the diversion is made. Pool a will, however, come into being immediately upon completion of construction and be stored in the unused zone allocated to future water supply. It will remain for a period of several years at the end of which the Metropolitan District will require all of the authorized water supply storage. At that time and for some years thereafter, Pool a will be discontinued. At a later date, when substantial amounts of stored water are diverted for domestic use, pool a will be re-established. Under an agreement to be included in the water supply contract, subject to approval by the District Board, the Metropolitan District will then maintain a portion of its total reserves in the

Colebrook River pool, subject to use in emergencies only. Since this storage constitutes only about 3 percent of the District's total supply, equivalent to a 2-week supply by the year 2000, it is unlikely that the District would deliberately draw its reserves to this point. Consequently, it is considered that this holdover storage is essentially the same as permanent storage. The initial provision of pool a will result in some enhancement, but its future reestablishment is for mitigation purposes. Provision of Pool a does not increase the project cost.

b. Pool b is for enhancement of the spring shad fishery. Water will be stored in the late winter and early spring and released in late April, May, and June. This pool will be stored in the flood control storage zone after the spring snowmelt runoff and be released prior to the hurricane season. The reduction in flood control benefits resulting from this seasonal use of about ten percent of the flood control capacity is considered negligible. Pool b will come into being upon completion of the project and remain operational during the life of the project. Provision of pool b requires additional reservoir clearing, but does not otherwise increase the project cost.

For a few years, while unused future water supply storage capacity is available, pool b will be operated within this zone. Thereafter, pool b storage will be contained in the flood control zone and any unused water supply storage capacity. In early spring as the water supply storage fills, pool b will rise into the flood control zone. Any pool b water which rises into the flood control zone prior to 1 April will be wasted and will be replaced by surplus water between 1 April and 15 April. In the event snowmelt runoff is delayed beyond 1 April and the water supply capacity has filled early in the season, the filling of pool b will be delayed so as to utilize surplus water from snowmelt.

c. Pool c is for enhancement of the sea-run brown trout fishery. Water will be stored in winter and early spring and released in August, September and October. This storage requires raising the dam by 5 feet. Pool c will come into being upon completion of the project and remain operational during the life of the project. Provision of pool c increases the project cost by \$400,000. Cost of increasing the height of dam will be borne by the Federal Government. In addition to the downstream fishery improvement for which it is provided, pool c will provide for additional general recreation including boating within the reservoir during the summer months. When the water supply capacity is full, the addition of pool c will increase the water level from Elevation 701 to Elevation 708 and increase the surface area from 710 acres to 750 acres. Assuming that the water supply pool is drawn to

Elevation 660 by 31 July, pool c will increase the water level to Elevation 670 and increase the surface area from 460 to 520 acres. An effort will be made to develop a strain of brown trout which runs after Labor Day so that all of pool c may be maintained during August, thus increasing the general recreation provided by pool c.

d. Provision of water rights required for initial filling and for operation of the fishery pools is the responsibility of the State of Connecticut and other local interests. Section 26-3 of the General Statutes of Connecticut provides in part that the Connecticut Board of Fisheries and Game "may enter into cooperative agreements with Federal agencies, municipalities, corporations, organized groups or landowners, associations and individuals for the development of game, birds, fish or fur-bearing animals management and demonstration projects. The board may allocate and expend for the protection, restoration, preservation and propagation of fish, crustacea, game and fur-bearing animals, and game and nongame birds, all funds of the state collected, appropriated and acquired for the purpose."

Under this authority, the board is vigorously negotiating towards agreements with the Allied Connecticut Towns, the Collins Company, and the Farmington River Power Company which will provide for the storage and use of surplus water which would otherwise be wasted and also those flows between 50 and 150 c.f.s. between 1 January and 15 April of each year. If successful, these negotiations will provide the necessary water rights for dependable operation of the fisheries pools without the necessity for legislation. The Board of Fisheries and Game discusses the availability of water at length in Exhibit 5.

e. Achievement of the anticipated fish runs will require the construction of fish passage facilities at the Rainbow Dam and on tributary streams. Preliminary plans and cost estimates are being prepared and the Board of Fisheries and Game has requested funds to construct these facilities.

S. COST ESTIMATES

64. Cost Estimates. - The total estimated cost of the project is \$15,000,000. A summary of the cost of the various features of the work described in this Design Memorandum is given in Table I. Breakdown of the estimate is shown in Table II starting on Page 58.

TABLE I

SUMMARY OF FEDERAL COSTS

(January 1964 Price Level)

<u>Project Feature and Sub Feature</u>	<u>Estimated Cost</u>
Lands and Damages	\$ 225,000
Relocations	5,250,000
Roads	
Connecticut Roads	2,600,000
Massachusetts Roads	2,600,000
Cemeteries and Utilities	50,000
Reservoir	130,000
Dam	7,400,000
Dam	7,300,000
Unwatering West Branch Reservoir	100,000
Road	135,000
Recreation	50,000
Buildings, Grounds & Utilities	90,000
Permanent Operating Equipment	40,000
Equipment	30,000
Sedimentation Bounds & Ranges	10,000
Engineering and Design	935,000
Supervision and Administration	<u>745,000</u>
 Total Estimated Project Cost	 \$15,000,000

65. Comparison of Estimates. - The following tabulation shows the comparison of the current cost estimate with the project document cost estimate:

<u>Project Feature</u>	<u>Current Estimate</u>	<u>Project Document Estimate</u>
Lands and Damages	\$,225,000	\$ 314,000 ⁽¹⁾
Relocations	5,250,000	2,777,000 ⁽²⁾
Reservoir	130,000	120,000
Dam		
Dam	7,300,000 ⁽³⁾	6,533,000
Unwatering West Branch Reservoir	100,000	(1)
Road	135,000	96,000
Recreation	50,000 ⁽⁴⁾	
Buildings, Grounds and Utilities	90,000	86,000

<u>Project Feature</u>	<u>Current Estimate</u>	<u>Project Document Estimate</u>
Permanent Operating Equipment	\$ 40,000	\$ 19,000
Preauthorization Studies	(5)	20,000
Engineering and Design	935,000	635,000
Supervision and Administration	<u>745,000</u>	<u>700,000</u>
Total Estimated Project Cost	\$15,000,000	\$11,300,000

- (1) Project document estimate for lands and damages included \$130,000 for unwatering West Branch Reservoir. Revised estimate of \$100,000 is included as a subfeature under "Dam".
- (2) Increase of \$2,473,000 in relocations is attributed to the following:
 - Price level changes.
 - New bridge and increased length of relocation in Massachusetts required because spillway was raised to maintain authorized reservoir capacity at the upstream site.
 - Increased length of relocation required for locating the dike at the watershed divide.
 - More difficult terrain at 14-foot higher elevation.
 - Increase in contingency allowance from 10 percent to 15 percent.
 - Inclusion of utility relocations not in original estimate.
- (3) Increase of \$767,000 in cost of dam is the net result of savings in project cost and increases due to price level changes; additional height for fish and wildlife storage and steel tunnel liner for future power.
- (4) New item.
- (5) Deleted.

T. COST ALLOCATION

66. Cost Allocation. -

a. General. - Cost allocation is based on the Use of Facilities method in accordance with the method used in the Interim (Survey) Report and the provisions of paragraphs 13b and c of EM 1165-2-105. Joint costs are allocated in proportion to the reservoir storage capacity provided for the respective purpose. The joint cost of the 5,000 acre-feet of conservation storage used seasonally for flood control and fish and wildlife improvement is allocated to flood control. This seasonal operation does not increase the flood control cost. Federal (flood control and fish and wildlife) and Non-Federal (water supply) costs are developed in Appendix B.

b. Specific Costs. - Cost of reservoir clearing is allocated as a specific cost for water supply and fish and wildlife. Reservoir clearing cost is allocated in proportion to the total storage utilized for each of these purposes. Recreation is excluded from the cost allocation. Recreational facilities to develop maximum collateral usage of the reservoir are not required for the water supply purpose. The steel tunnel lining and tunnel reinforcement are excluded from the cost allocation.

c. Cost Allocation Without Fish and Wildlife. - Cost allocation has been prepared without fish and wildlife as a project purpose. This allocation is also included in Appendix B.

d. Summary of Cost Allocations. - The total first cost of the project is shown in Table III, Summary of Cost Allocations.

TABLE III

SUMMARY OF COST ALLOCATIONS

Federal

Flood Control		\$8,658,000
Fish and Wildlife		886,000
Not allocated		120,000
Future Power	63,000	
Recreation	57,000	
		<hr/>
Total Federal First Cost		\$9,664,000

Non-Federal

Water Supply for immediate use		\$ 836,000
Future Water Supply		<u>4,500,000</u>
Total Non-Federal First Cost		\$5,336,000
<u>TOTAL PROJECT FIRST COST</u>		\$15,000,000

U. SCHEDULES FOR DESIGN AND CONSTRUCTION

67. Design. - Preparation of plans and specifications for a multi-component contract which will include the construction of the dam and appurtenant was completed in the first half of Fiscal Year 1965. Preparation of plans and specifications for relocation of Route 8 will be completed by the Connecticut State Highway Department and the Massachusetts Department of Public Works in the second half of Fiscal Year 1965. Reservoir clearing will be accomplished under a separate contract with plans and specifications being completed in Fiscal Year 1967. Cemetery relocation will also be accomplished under a separate contract with plans and specifications being completed in early Fiscal Year 1966. Plans and specifications for operator's quarters and utility building will be prepared in Fiscal Year 1968 so that full advantage may be taken of any of the contractor's facilities such as grading, water supply well, and disposal field.

68. Construction. - It is estimated that four and one-half construction seasons will be required for construction of the project.

69. Relocations. -

a. Road Relocation. - Route 8 relocation will be initiated in the summer of 1965. Construction will extend over 2-1/2 construction seasons being completed in the fall of 1967. The relocations will be accomplished under agreements with the Connecticut State Highway Department and Massachusetts Department of Public Works which will administer the separate construction contracts for the work in their respective States.

b. Utilities Relocation. - The existing telephone and power lines along Route 8 will be relocated along the new road under separate contracts to be negotiated with the respective utility companies in Fiscal Year 1965 and will be completed in the fall of 1967.

c. Cemetery Relocation. - The cemetery will be relocated under a separate contract to be awarded in the spring of 1966, with work to start after Memorial Day, and completed in the fall of 1966.

70. Dam and Appurtenant Structures. - Construction of the dam, dike, outlet works, spillway, and access road will be accomplished under a single continuing contract to be advertised and awarded as soon as possible in Fiscal Year 1965. The construction will be performed in accordance with the following schedule:

a. First Season. - During the first (1965) season, the contractor will construct the inlet and outlet channels, the tunnel, the lower portion of the control tower and the outlet portal. Ends of the inlet and outlet channels will be left unexcavated to protect the construction in the event of high water. The contractor will also clear the work area, construct the access road, clear and strip borrow areas and initiate construction of the dike. In addition, the contractor will excavate a temporary diversion channel, construct temporary cofferdams, excavate, grout and backfill the cutoff trench and construct initial embankment fills to Elevation 600. Spillway rock excavation will be initiated to provide rock fill.

b. Second Season. - During the second (1966) construction season, the contractor will place any remaining concrete in the lower portions of the outlet works. He will divert the river through the tunnel and construct the cofferdams. He will place the lower portion of the dam embankment to Elevation 635. Spillway rock excavation will be accomplished as necessary to provide rock-fill for the embankment.

c. Third Season. - During the third (1967) construction season, the contractor will complete the dam embankment to Elevation 720.

d. Fourth Season. - During the fourth (1968) construction season, the contractor will complete the control tower, service bridge and the dam and dike embankments. The spillway weir will be concreted late in the season.

e. Fifth Season. - During the spring of the fifth season, the contractor will pave the access road and top of dam and dike, seed the borrow areas and perform any necessary cleanup operations to complete the work.

71. Reservoir Clearing. - Reservoir clearing will be accomplished under a separate contract to be awarded in the fall of 1967.

72. Operator's Quarters and Utility Building. - Operator's Quarters and Utility Building will be constructed under a separate contract to be awarded in 1968.

73. Funds Required. - The construction schedule is based on funding of \$500,000 in Fiscal Year 1965 for completion of design, lands and damages and for initiating construction of the dam during the latter part of Fiscal Year 1965; and on the assumption that additional funds will be appropriated as required. Accordingly, it is estimated that funds will be required approximately as follows:

<u>Fiscal Year</u>	<u>Construction Schedule Amounts Required</u>
1965	\$ 500,000
1966	3,200,000
1967	5,500,000
1968	<u>5,236,000</u>
Sub-Total	\$14,436,000
Allotted through FY 1964	<u>564,000</u>
TOTAL	\$15,000,000

V. RESERVOIR REGULATION

74. Reservoir Regulation. - Colebrook River Reservoir will be regulated to reduce flood flows at downstream damage centers on the Farmington and Connecticut Rivers. Key damage centers in the Farmington River Basin are: Riverton, New Hartford, Collinsville, Unionville, Farmington, Simsbury, Tarrifville, and Rainbow. The reservoir will also be regulated in conjunction with other reservoir projects in the Connecticut River Basin to modify floods on the Connecticut River at Windsor, Hartford, East Hartford, Glastonbury and Middletown. Typical regulation of Colebrook River Reservoir for the flood of August 1955 and standard project flood is shown on Plate Nos. 2-23 and 2-24 in Design Memorandum No. 2.

75. Frequency of Filling. - It is not possible to determine a precise stage-frequency relationship for Colebrook River Reservoir. The frequency of utilization of flood storage can be reasonably estimated from regulation at existing reservoirs, but the reservoir stage attained during a flood will be dependent on the concurrent stage of the water supply and fisheries pools at the beginning of the flood. Variations in the water supply pool are expected in the future as the water supply needs increase in the metropolitan area. It is assumed that the water supply and fisheries pools will be filled annually from snow melt, and quite frequently the spring regulation will cause some use of the flood control storage. On this basis, it is estimated that the more frequent stages may occur as follows:

<u>Frequency in Years</u>	<u>Reservoir Elevation</u>
1	715
2	720
5	728

For purposes of real estate acquisitions, it is considered that the reservoir may be filled to spillway crest an average of

about once in 100 years. Table 2-8 in Design Memorandum No. 2 lists the volume of storage that will be utilized for flood control for various frequencies.

76. Regulation of Water Supply Pool. - The regulation of the water supply pool will be accomplished to meet the needs of the Hartford Metropolitan District. As these needs increase, the manner of regulation will be adjusted from time to time. Under present conditions, downstream flows are regulated by State law which requires that the Metropolitan District release a minimum discharge of 50 c.f.s. at Goodwin Dam. This flow is considerably greater than the natural flow for extended periods in dry years. Also by riparian agreement and agreement with the Allied Connecticut Towns the Metropolitan District must pass all inflows into the West Branch Reservoir up to 150 c.f.s. The riparian agreement further provides that the District must pass the discharge from the Otis Reservoir watershed and release 21.7 billion gallons (66,000 acre-feet) of stored water annually. Releases are made on request of the riparian owners and are used for power generation. Operation of the power plants results in considerable variation in flow below the Collinsville and Rainbow Dams. When these plants are shut down, the streamflow drops off to about 25 c.f.s. at each of the plants until their storage ponds refill. At times, particularly on weekends, this low flow has resulted in objectionable conditions.

On completion of the project, the Hartford Metropolitan District will have available the water supply storage allocated to immediate use. This amounts to 4,800 acre-feet. The District has indicated that they may take 15,350 acre-feet on completion of the project, an additional 10,100 acre-feet in 1973 and the remainder, 5,250 acre-feet, in 1978. The District desires to "retain flexibility on this matter to the extent that a decision on the amount to be taken for immediate use be deferred until the construction of the project nears completion and that the balance be taken at times as indicated by our actual water supply demands". The water supply pool will normally be filled in the spring. It will be utilized to meet the riparian commitment in the same manner as the present West Branch storage is used. It will be drawn down starting on or soon after 15 May of each year with drawdown extending through the summer months. Except for a small reserve to maintain a minimum flow of 50 c.f.s., all of the Colebrook River - West Branch storage will be drawn off by 31 October. Contingent upon the availability of the necessary water and water rights, the storage capacity allocated to future water supply will be utilized for fish and wildlife and general recreation until it is needed for its authorized purpose.

Any of the future water supply storage which is not taken immediately will probably be required before the expiration of the

10-year interest free period and will then be used in the same manner for meeting the riparian commitment. With the increased capacity, it is expected that the water supply storage will not fill every year. On the basis of 42 years of record, the water supply storage would have failed to fill in 3 years.

On completion of the Goodwin Dam-Barkhamsted diversion tunnel by about 1975 and with increasing domestic demands, filling of the reservoir will become less frequent. Available flow will continue to be utilized to meet the riparian commitment.

Some time after 1975 the riparian commitment is expected to be eliminated or very substantially reduced by the purchase of water rights. It is probable that this will not be done suddenly or all at one time. Operation for domestic requirements will be much the same as for riparian needs. However, the rate of draw-down during the summer will be reduced and the drawdown extended into the fall and winter months. After substantial amounts of the stored water are diverted, at least 5,000 acre-feet of holdover storage will be maintained in the Colebrook River pool above the dam. This storage will be available for domestic use under extreme drought conditions. Under normal conditions, it will provide a minimum pool for the maintenance of a fishery within the reservoir and will offset fishery losses downstream of the project due to diversion of streamflow for water supply.

The tentative agreement for maintenance of the holdover pool prepared for inclusion in the formal contract for provision of water supply storage reads as follows:

"The future plans of the District provide for the construction of a tunnel from the Goodwin Dam to the Barkhamsted Water Supply Reservoir and diversion of the stored water for domestic use. The District agrees that, at such time as substantial amounts of the stored water are diverted, either by means of the proposed tunnel or otherwise, it will operate its storage in such a manner as to maintain 5,000 acre-feet of water in the Colebrook River Reservoir as holdover storage. The holdover storage will not be used except in cases of emergency as determined by the District and will not be included in the District's normal reserve storage required to fulfill minimum flow release requirements."

77. Regulation of Fisheries Pools. - The proposed regulation of the fisheries pools is described in Paragraph 63. In regard to operation of these pools, it is considered that final authority should rest with the Corps of Engineers since this is a Federal

project. Operation will be accomplished in accordance with the recommendations of the U. S. Fish and Wildlife Service and the Connecticut Board of Fisheries and Game subject to operational requirements.

If the water rights for operation of the fisheries pools cannot be obtained by cooperative (voluntary) agreement, or as a result of legislative action, then Pool c can be maintained as a permanent pool. Initial filling can be accomplished using surplus water which would otherwise be wasted by the Metropolitan District, the Collins Company, and the Farmington River Power Company.

W. OPERATION AND MAINTENANCE

78. General. - The Colebrook River Dam will be operated and maintained by the United States under the supervision of the Division Engineer, Waltham, Massachusetts. Basic recreational facilities will be maintained and operated by the States of Connecticut and Massachusetts.

79. Operation of the Reservoir. - Colebrook River Reservoir will be regulated to reduce flood flows at the downstream damage centers on the Farmington and Connecticut Rivers. Regulation for the Farmington River will be coordinated with the outflow from the unattended Mad River Dam. Regulation for the Connecticut River will be coordinated with 12 existing flood control reservoirs located in the Connecticut River Basin upstream of the Farmington River. The basic data required for proper regulation during flood periods, will be collected by means of a hydrologic radio reporting network. Gage readings from key index stations on the Farmington and Connecticut Rivers and the pool elevation at Mad River Dam will be included in the radio network.

The water supply storage will be regulated in accordance with the needs of the Hartford Metropolitan District.

The fish and wildlife storage will be regulated in accordance with the recommendations of the Connecticut Board of Fisheries and Game.

80. Maintenance. - Periodic inspection of the dam and appurtenant structures and equipment will be made. The dam and appurtenant structures will be maintained and operated by a staff consisting of a dam operator and an assistant dam operator and one or two part-time employees. Maintenance will be based on regular detailed inspection of the entire works, including all operations necessary to preserve the structures.

81. Annual Charges. - The estimated annual cost of maintenance and operation of the Colebrook River Dam and Reservoir is \$32,000, exclusive of cost of maintaining basic recreational facilities. The estimated annual cost of major replacements is \$6,000.

X. HEALTH CONTROL

82. Water Quality Control. - Consideration was given to the provision of additional storage to provide releases for water quality control. The State of Connecticut is requiring construction of secondary treatment plants within the watershed which are expected to improve the quality of the Farmington River water. The Regional Office of the Department of Health, Education and Welfare indicates that there are no tangible benefits to be derived from the including of storage for streamflow regulation for quality control. They indicate that provision for a minimum flow of 50 c.f.s. at Collinsville and Rainbow Dams is desirable. Such provision would be a State or local responsibility and not within the realm of Federal participation. Their letter of 10 January 1964 is reproduced as Exhibit 7. By letter of 23 November 1964, the Regional Office informed us that they have no additional comments to make concerning this project at this time.

83. Vector-borne Disease and Control. - The United States Department of Health, Education and Welfare reported that the malaria mosquito occurs throughout the State of Connecticut, but normally it is not abundant, and malaria is not of public importance in that State. Eastern equine encephalitis is not a common disease, and no human cases have occurred in Connecticut. However, outbreaks of this disease have occurred in Connecticut among captive pheasants and a serious outbreak occurred in Massachusetts in 1956, involving 16 human cases, 41 horse cases, and 12 pheasant farms. The mosquito is suspected as a transmitter of this disease.

The construction of storage reservoirs should be beneficial from a mosquito control standpoint since some swampy areas would be inundated and flooding in downstream areas would be diminished. Operations of the water supply pool at the Colebrook River site might afford sufficient fluctuation in the water surfaces in the summer months to deter the growth of mosquito larvae.

The U. S. Department of Health, Education and Welfare recommends that, in order to avoid the creation of vector mosquito problems, the following principles be adhered to in the development of more detailed plans for the design, construction, and operation of the projects:

- (a) Clear the reservoir sites of trees and brush.
- (b) Locate borrow pits, if possible, where they will be permanently inundated.

- (c) Provide drainage ditches for the elimination of seepage areas and similar types of ponded water.
- (d) Remove flotage, secondary growth, and/or aquatic plants as necessary after impoundment.
- (e) Provide, in the maintenance program, for regular and frequent field surveys to determine the amount of mosquito breeding.
- (f) Provide for chemical measures to control excessive production of mosquitoes, especially during the high flood crests.
- (g) Keep the interested states and United States Department of Health currently advised regarding project construction schedules, so that guidance, consultation, and specific recommendations may be provided with regard to the vector problems associated with these projects.

Y. HYDROPOWER

84. Hydropower. - The Flood Control Act of 1960, under which the project is authorized, provides "That penstocks and other similar facilities adapted to possible future use in the development of hydroelectric power shall be installed in any dam authorized in this Act for construction by the Department of the Army when approved by the Secretary of the Army on the recommendation of the Chief of Engineers and the Federal Power Commission." As a result of studies made by the New York Regional Office of the Federal Power Commission and the New England Division of the Corps of Engineers, it was found that only a slight modification of the plan will be necessary to provide for the future development of hydroelectric power. Letter of the Regional Engineer, dated 18 December 1963, which concludes that the Colebrook River project as designed for flood control and water supply can be utilized for future power development and that the proposed outlet tunnel should be designed initially for possible use as a power penstock, is reproduced as Exhibit 8.

As proposed, the future 5,000 kilowatt hydroelectric installation would require acquisition of necessary rights in the Goodwin Dam and its West Branch Reservoir to permit use of the storage capacity for flood control. It would also be necessary to modify the existing outlet works in Goodwin Dam to increase the discharge capacity of the gates so that flood control storage capacity can be emptied rapidly and to prevent filling of this capacity by minor freshets not requiring reservoir regulation.

If necessary rights in West Branch Reservoir cannot be obtained or are too costly, operation of a power plant at a reduced

head would be feasible. After a flood control operation, the Colebrook River pool would be at Elevation 708 with West Branch Reservoir at spillway crest, Elevation 641. This would provide a head of 67 feet. By holding back on releases for power generation, the head could be increased as the West Branch Reservoir is drawn down for water supply and downstream commitments.

Consideration was given to reinforcing the concrete tunnel lining for internal pressures, to providing a steel lining initially so as to permit its future use as a power penstock or to a future steel lining. Assuming that reinforcement or lining would be required downstream of the centerline of dam only, comparative estimates were developed.

Steel reinforcement of the concrete lining was found to be the most economical. Steel lining was included for 20 feet at the outlet portal to facilitate the future connection to the powerhouse.

The increased height of dam for fish and wildlife increases the amount of potential future hydroelectric power. If the pool were made permanent, there would be a further increase because of the greater head. In addition, the permanent pool would eliminate the possibility of having to shut down the plant during a water supply emergency. This last might make the installation much more attractive to a potential licensee.

As power is not a full project purpose, costs and benefits are excluded from the cost allocation. Benefits are considered sufficient to warrant the cost of the 20-foot section of steel liner and steel reinforcement of the tunnel lining as Federal costs. These costs are estimated to be \$63,000 including contingencies, engineering, supervision and administration. Annual costs for interest and amortization are \$2,100.

In letter of 17 August 1964, reproduced as Exhibit 9, the Federal Power Commission stated that the increased height of dam would improve the amount of potential power but the additional costs involved could not be supported by power only. They indicated that power operation as described in the third sub-paragraph above is satisfactory at times of major floods. The proposed power installation is described in the letter and shown on the inclosed sketch reproduced following the letter.

Z. BENEFITS

85. General. - The Farmington River and its tributaries have a long history of industrial development. Metal products of many types - ball bearings, edgetools, springs, spring steel and electrical appliances are the mainstays in the economy of several towns along the middle reaches of the river.

Agriculture is important to the economy of the lower portion of the basin, especially in the lower lying portion of the land, although changes in demand in the tobacco industry coupled to the advancing urbanization of the whole lower valley is lessening this importance.

Nineteen lives were lost and damages estimated at over \$28,000,000 were experienced on the main stem of the Farmington River downstream of the junction of its East and West Branches in New Hartford in the record flood of August 1955. In a recurrence of this flood under current economic conditions and with Mad River Reservoir in operation, losses would amount to \$31,650,000 in the Farmington River Basin without additional flood control measures. The total damages prevented in the entire watershed by Colebrook River Reservoir acting in a system with Mad River and Sucker Brook would amount to \$21,700,000 in a recurrence of the 1955 flood.

86. Flood Damage Prevention Benefits. - Average annual flood damage prevention benefits for Colebrook River Dam and Reservoir were derived by determining the difference in annual losses on the reaches of the Farmington downstream of the dam after reductions by Mad River Reservoir and Colebrook River Dam. In addition to reductions in flows on the Farmington River, the project is credited with reductions on the main stem of the Connecticut River acting incrementally after a system of 16 reservoirs, built or authorized. Annual benefits, so derived, adjusted for the growth projected to take place in the basin over the life of the project amount to \$597,000.

87. Water Supply Benefits. - The Colebrook River site is the most economically feasible site for the storage of water supply for the Hartford Metropolitan District. It is located where discharges for water supply would empty into West Branch Reservoir from which they would be diverted through a tunnel to the Barkhamsted water supply reservoir. The District has confirmed the view that the West Branch, Farmington River is their most important potential source for future water supply.

It is assumed, in view of the foregoing, that a single purpose water supply reservoir at the Colebrook River site would be the alternative project most likely to be constructed for the District's long term needs. Short term needs would most likely be met by following the original plans for constructing the District's Goodwin Dam to Barkhamsted Reservoir diversion tunnel and acquisition of water rights. By 1992, after constructing the tunnel and purchasing the 52 m.g.d. of the riparian commitment which is suitable for domestic use, the District's domestic requirement and available usable supply would both approximate 114 m.g.d. Accordingly, it would be necessary to develop additional supplies by that time. Completion of the alternative project is therefore assumed for 1992 or 23 years after completion of the Colebrook River project in 1969. Benefits for this alternative project are considered to be at least equal to its cost,

discounted to reflect its "present worth" as of 1969. The cost of a single purpose water supply project with 10 billion gallons of storage is estimated to be \$9,324,000 at 1964 prices. Using a 100-year life and 3-1/4 percent interest rate, annual charges are computed in Table IV below:

TABLE IV

SINGLE PURPOSE WATER SUPPLY PROJECT

Total Investment

Total Project First Cost	\$9,324,000
Interest during Construction (3 years)	<u>454,500</u>
Total Investment	\$9,778,500

Annual Charges

Interest (3.25% x \$9,778,500)	\$ 317,800
Amortization (.00138 x \$9,778,500)	13,500
Maintenance and Operation	27,000
Major Replacements	<u>6,000</u>
Total Annual Charges	\$ 364,300

Present Worth \$364,300 x 0.4792 = \$ 174,600

It is assumed that the average annual domestic water supply benefits are at least equal to this amount, that is \$174,600 rounded to \$175,000.

In addition to water supply benefits, the Colebrook River project meets the need for downstream riparian flows on a temporary basis until the entire capacity is needed for the domestic system. Purchase of riparian rights, estimated to cost \$1,350,000 in 1968, would cost \$27,000 more on an annual basis than the same purchase made in 1992. The benefits resulting from the alternative single purpose project, \$175,000, are therefore increased by \$27,000 to \$202,000.

88. Fish and Wildlife Benefits. -

a. Benefits resulting from improvement of the downstream fishery have been estimated by the Fish and Wildlife Service. As shown in Exhibits 2 and 4, these benefits are \$54,000 and \$30,000, respectively, for the shad and sea-run brown trout. Surplus water will be available for operation of the fishery pools for some years. Water for

dependable operation of the fishery pools will ultimately have to come from flows under 150 c.f.s. Acquisition of riparian rights for these flows will probably be required. Water rights will be purchased by the State of Connecticut. Purchase of each 5,000 acre-feet is expected to cost \$12,700 annually. This amount is discounted to a present worth value of \$10,000 since these water rights will not be required for about 10 years. This results in net values of \$44,000 for the shad fishery and \$20,000 for the sea-run brown trout.

b. In-reservoir Benefits. - In addition to the downstream fishery improvement, the addition of pool c will improve fishing within the reservoir. As shown in Exhibits 3 and 4 the annual fishery benefits are \$36,000. This benefit will be valid even in the event that pool c might not be used for fall releases. Incremental annual costs for pool c are about \$15,000. Therefore, pool c is incrementally justified on the basis of reservoir fishery benefits alone. Total annual fish and wildlife benefits are \$100,000.

c. Other Benefits.- As noted in Exhibit 1, the Commonwealth of Massachusetts concurred with the project subject to the understanding that it would be so operated as to preclude the need for drawing down Otis Reservoir during the recreational period from 1 June to 1 October each year. An agreement between the Collins Company and the Commonwealth of Massachusetts to this effect is being formalized. No evaluation of fishery or recreation improvements in Otis Reservoir in Massachusetts resulting from agreement to eliminate summer drawdown has been made. Although elimination of this drawdown is only indirectly connected with the project, it is considered unlikely that the agreement could have been reached without the flexibility of operation which availability of the water supply storage provides.

89. Redevelopment Benefits. - In addition to flood damage prevention and fish and wildlife and water supply benefits, the project will provide redevelopment benefits by utilizing labor currently unemployed or underemployed. The entire northwest portion of Connecticut and the southwest portion of Massachusetts has been designated as an area of substantial unemployment by the U. S. Department of Labor. Two towns within 25 miles of the reservoir site have been designated as ARA areas by the Area Redevelopment Administration.

Redevelopment benefits have been computed for the project based on the estimated labor cost of the work with allowances made for the proportion of labor which will be hired locally and the number of those hired who would otherwise be unemployed or underemployed. Benefits so derived amount to \$1,843,000 over a four-year period. Expressed as an average annual equivalent benefit over the life of the project, this amounts to \$55,000.

90. General Recreation Benefits. - General recreation is excluded from the cost allocation. The project will provide opportunity for hiking, picnicking, nature walks and similar activities. Although these opportunities are presently available on Metropolitan District lands, it is expected that the project will increase such activities by 10,000 visitor days resulting in an annual benefit of \$5,000 based on \$0.50 per visitor day. The project will also afford greatly increased opportunities for boating by others than fishermen using motor boats, canoes and sailboats. Estimated usage is 22,600 boaters annually, resulting in a benefit of \$22,600 based on \$1.00 per visitor day. Total non-fishing general recreational benefits are \$27,600.

91. Future Power Benefits. - Future power is excluded from the cost allocation. Benefits from the installation of the steel tunnel liner are considered at least sufficient to justify the incremental cost. Annual benefits for future hydropower development are therefore \$2,100.

92. Total Annual Benefits. - The total of the average annual benefits is \$983,700 as shown in the following summary:

SUMMARY OF BENEFITS

<u>Purpose</u>	<u>Benefit</u>
Flood Control	\$597,000
Water Supply	202,000
Fish and Wildlife	100,000
Recreation	27,600
Redevelopment	55,000
Future Power	<u>2,100</u>
TOTAL	\$983,700

93. Annual Charges. - Annual charges shown in Table V have been computed in accordance with OCE circular Letter ENG CW-PD, Subject: "Policies, Standards and Procedures in the Formulation, Evaluation and Review of Plans for Use and Development of Water and Related Land Resources", dated 15 June 1962, using an economic life of 100 years for the project. The physical life of the project components and the anticipated continuing need for flood control and water supply indicate a long term economic project life. Annual charges have been computed assuming that all future water supply storage will be used for meeting the riparian commitment in 10 years. The probable use of future water supply storage within the 10-year interest free period will reduce the Federal annual charge for interest on water supply storage. Loss of taxes on land and adjustment for loss of productivity of land included in prior reports has been omitted. This is in accordance with the provisions of S 97 and the fact that

farming units in the area are not considered as being economical. Three years has been used as the construction period since the drawdown of the West Branch Reservoir will provide partial flood protection during the construction period.

TABLE V

INVESTMENT AND ANNUAL CHARGES

FEDERAL INVESTMENT

First cost of flood control, fish and wildlife improvement, recreation and future power	\$ 9,664,000
Interest during construction $9,664,000 \times .03 \times 1.5 =$	<u>434,900</u>
Investment in flood control, fish and wildlife improvement, recreation and future power	\$10,098,900
First cost of future water supply	\$ 4,500,000
Interest during construction $4,500,000 \times .03 \times 1.5 =$	<u>202,500</u>
Investment in future water supply	\$ 4,702,500
First cost of water supply for immediate use	\$ 836,000
Interest during construction $836,000 \times .03 \times 1.5 =$	<u>37,600</u>
Investment in water supply for immediate use	\$ 873,600
TOTAL FEDERAL INVESTMENT	\$15,675,000
<u>NON-FEDERAL INVESTMENT</u>	None
TOTAL INVESTMENT	\$15,675,000

ANNUAL CHARGES

Based on the first use of Future Water Supply

Storage 10 Years after Project Completion

<u>Flood Control, Fish and Wildlife Improvement, Recreation and Future Power</u>	<u>Federal</u>	<u>Non-Federal</u>	<u>Total</u>
Interest on allocated investment (10,098,900 x .03)	302,970	---	302,970
Amortization on allocated investment (10,098,900 x .00165)	16,660	---	16,660

TABLE V(continued)

<u>Flood Control, Fish and Wildlife Improvement, Recreation and Future Power (Cont'd)</u>	<u>Federal</u>	<u>Non-Federal</u>	<u>Total</u>
Maintenance and operation for first 10 years (32,000 x 94.45 x 8.53 x 0.03165)	\$ 8,160	---	\$ 8,160
for last 90 years (32,000 x 64.51 x 31.002 x .7441 x .03165)	15,070	---	15,070
Major Replacements for first 10 years (6,000 x 94.45 x 8.53 x 0.03165)	1,530	---	1,530
for last 90 years (6,000 x 64.51 x 31.002 x .7441 x .03165)	<u>2,830</u>	<u>---</u>	<u>2,830</u>
Total Annual Charges for Flood Con- trol, Fish and Wildlife Improve- ment, Recreation and Future Power	\$347,220	---	\$347,220
 <u>Water Supply</u>			
Interest on investment for future water supply storage, 30% of pro- ject costs, for 10 years (\$4,702,500 x .03 x 8.530 x .03165)	38,080	---	38,080
Interest on investment for future water supply storage for 90 years (\$4,702,500 x .03 x 31.002 x .7441 x .03165)	---	103,000	103,000
Amortization of investment for future water supply storage (\$4,702,500 x 31.002 x .7441 x 0.03165 x 0.00226)	---	7,760	7,760
Interest on investment for water sup- ply storage for immediate use (873,600 x .03)	---	26,210	26,210
Amortization of investment for water supply storage for immediate use (873,600 x 0.00165)	---	1,440	1,440
Maintenance and operation for first 10 years (32,000 x 5.55% x 8.53 x 0.03165)	---	480	480
for last 90 years (32,000 x 35.49% x 31.002 x .7441 x 0.03165)	---	8,290	8,290

8,770

TABLE V (continued)

<u>Water Supply (continued)</u>	<u>Federal</u>	<u>Non-Federal</u>	<u>Total</u>
Major replacements for first 10 years (6,000 x 5.55% x 8.53 x .03165)	---	2,770 \$ 90	\$ 90
for last 90 years (6,000 x 35.49% x 31.002 x .7441 x .03165)	---	<u>1,550</u>	<u>1,550</u>
Total Annual Charges for Water Supply	\$38,080	\$148,820	\$186,900
TOTAL ANNUAL CHARGES	\$385,300	\$148,820	\$534,120

94. Benefit-Cost Ratio. - The ratio of benefits to costs is \$983,700 to \$534,120 or 1.8 to 1.

AA. RECOMMENDATION

95. Recommendation. - It is recommended that the revised project plan including fish and wildlife as a primary project purpose, submitted in this memorandum, be approved as a basis for preparation of detailed Design Memoranda and contract plans for the Colebrook River Dam and Reservoir Project.

TABLE II

DETAILED COST ESTIMATE
(January 1964 Price Level)

<u>Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Estimated Amount</u>
<u>01. Lands and Damages</u>				
Lands, Acquisition and Resettlement				\$ 215,000
Contingencies				<u>10,000</u>
TOTAL LANDS AND DAMAGES				\$ 225,000
<u>02. Relocations</u>				
.1 Roads				
(a) Route 8 in Connecticut				\$2,217,000
(b) Route 8 in Massachusetts				2,212,000
(c) Beech Hill Road Connector				37,000
.3 Cemeteries and Utilities				
Contingencies				<u>46,000</u>
TOTAL RELOCATIONS				\$5,250,000
<u>03. Reservoir</u>				
.1 Reservoir Clearing (350 ac.)				
.2 Log Boom				\$ 110,000
Contingencies				5,000
				<u>15,000</u>
TOTAL RESERVOIR				\$ 130,000
<u>04. Dam</u>				
.1 Dam (including Dike)				
Preparation of Site	1	Job	L.S.	\$ 52,000
Control and Diver-				
sion of Water	1	Job	L.S.	100,000
Unclassified Ex-				
cavation -General	130,000	C.Y.	\$0.80	104,000
Unclassified Ex-				
cavation - Im-				
pervious Borrow	700,000	C.Y.	0.45	315,000

TABLE II (continued)

<u>Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Estimated Amount</u>
04. Dam (continued)				
Rock Excavation - Open Cut	890,000	C.Y.	\$2.20	\$1,958,000
Rock Excavation - Tunnel	4,900	C.Y.	30.00	147,000
Line Drilling	14,700	S.F.	2.50	36,750
Safety Mesh	22,300	S.Y.	2.00	44,600
Rock Bolting	200	Each	16.00	3,200
Machine Cleaned Bed- rock Surfaces	1,650	Square (100sq.ft)	8.00	13,200
Hand Cleaned Bedrock Surfaces	1,000	Square (100sq.ft)	18.00	18,000
Compacted Impervious Fill	600,000	C.Y.	0.16	96,000
Special Impervious Fill	7,200	C.Y.	5.00	36,000
Compacted Pervious Fill	700,000	C.Y.	0.74	518,000
Compacted Gravel Fill	250,000	C.Y.	1.20	300,000
Rock Filter	95,000	C.Y.	4.00	380,000
Compacted Processed Sand Fill	5,200	C.Y.	3.00	15,600
Gravel Bedding	16,000	C.Y.	2.00	32,000
Rolled Gravel Base	4,100	C.Y.	1.50	6,150
Additional Rolling for Compaction	100	Hrs.	20.00	2,000
Rock Fill	1,100,000	C.Y.	0.50	550,000
Rock Slope Protection	24,200	C.Y.	3.00	72,600
Tunnel Drilling and Grouting	1	Job	L.S.	15,000
Foundation Drilling and Grouting	1	Job	L.S.	150,000
Anchor Bars - #10	126	Each	30.00	3,780
Anchor Bars - #11	127	Each	35.00	4,445
Concrete - Spillway Weir	3,350	C.Y.	30.00	100,500
Concrete - Channel Lining	620	C.Y.	60.00	37,200
Concrete - Inlet Structure	340	C.Y.	40.00	13,600
Concrete - Tunnel Lining	1,570	C.Y.	50.00	78,500
Concrete - Tunnel Transition	730	C.Y.	60.00	43,800
Concrete - Intake Tower to Elev. 631.0	4,800	C.Y.	30.00	144,000
Concrete - Intake Tower from Elev. 631.0 to Elev. 775.17	1,230	C.Y.	60.00	73,800

TABLE II (continued)

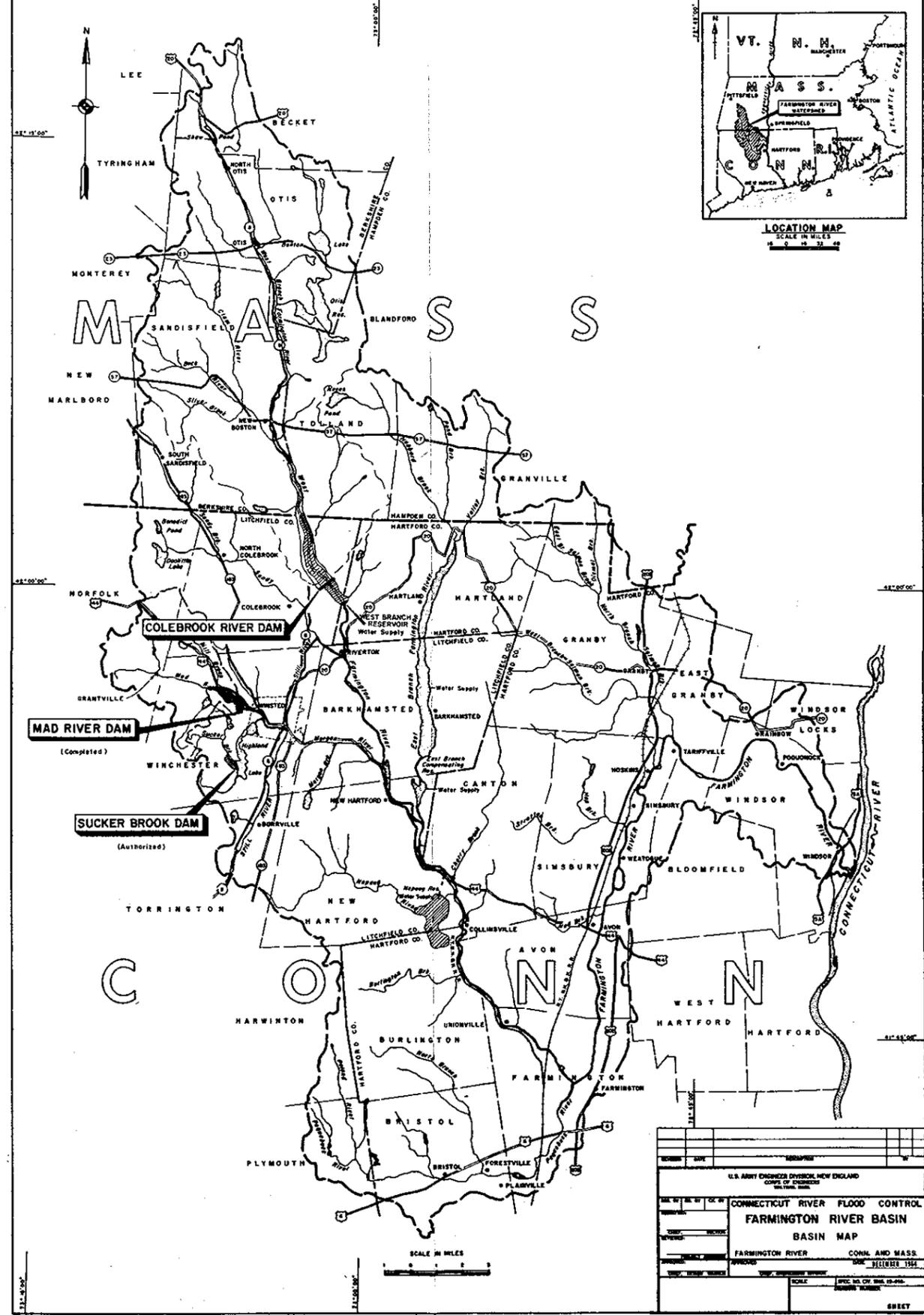
<u>Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Estimated Amount</u>
04. Dam (continued)				
Concrete - Intake Tower above Elev. 775.17	240	C.Y.	\$110.00	\$ 26,400
Concrete - Service Bridge Abutment and Pier	450	C.Y.	30.00	13,500
Concrete - Bridge Super- structure	120	C.Y.	100.00	12,000
Concrete for Foundation Preparation	100	C.Y.	45.00	4,500
Tunnel Rib Supports				
a. First 50 Supports	50	Each	200.00	10,000
b. Over 50 Supports	50	Each	200.00	10,000
Steel Tunnel Lining	20	L.F.	500.00	10,000
Portland Cement	20,200	Bbl.	5.00	101,000
Steel, Reinforcement	1,000,000	Lbs.	0.15	150,000
Waterstops - Type B	1,300	L.F.	3.00	3,900
Intake Tower - Super- structure	1	Job	L.S.	10,000
Float Well & Accessories	1	Job	L.S.	8,000
Air Vent System	1	Job	L.S.	40,000
Elevator	1	Job	L.S.	25,000
Exterior Monorail Hoist	1	Job	L.S.	15,000
Miscellaneous Metals	8,800	Lbs.	0.90	7,920
Structural Steel - Miscellaneous	105,000	Lbs.	0.50	52,500
Structural Steel - Service Bridge	1	Job	L.S.	70,000
Aluminum	7,700	Lbs.	2.00	15,400
Diesel-Electric Genera- tor Set	1	Job	L.S.	20,000
Heating and Ventilating System	1	Job	L.S.	5,000
Gates and Accessories	1	Job	L.S.	400,000
Emergency Stop Gate	1	Job	L.S.	30,000
Interior Monorail Hoist	1	Job	L.S.	10,000
Interior Electrical Work	1	Job	L.S.	10,000
Exterior Electrical Work	1	Job	L.S.	60,000
Gages, Tile and Staff	1	Job	L.S.	5,000
Cable Guide Railing	5,150	L.F.	3.00	15,450
Chain Link Fencing, 4 feet high	3,000	L.F.	2.50	7,500
Entrance Gate	1	Job	L.S.	1,000
Sump Pump, Complete	1	Job	L.S.	1,000

TABLE II (continued)

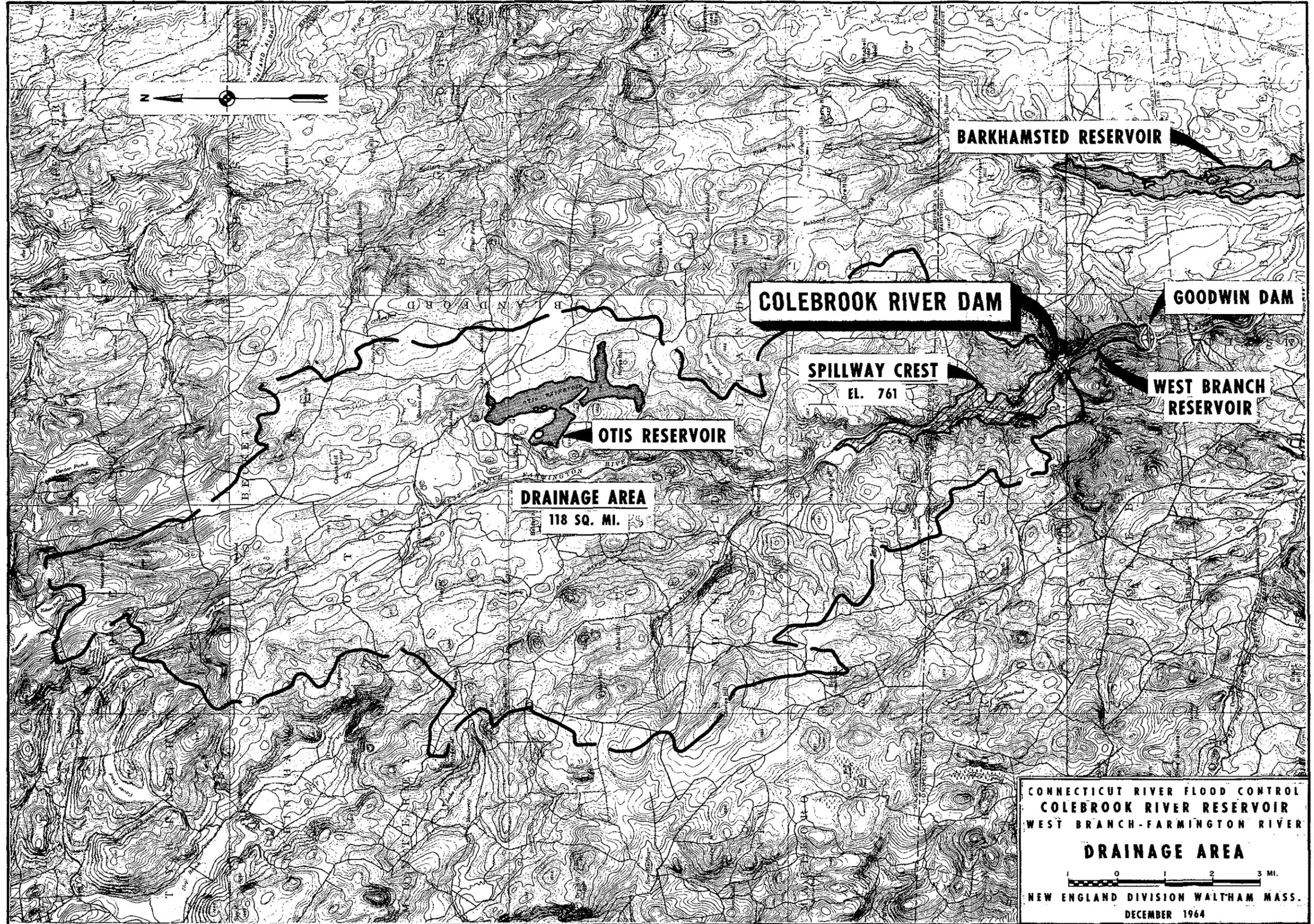
	<u>Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Estimated Amount</u>
04.	<u>Dam (continued)</u>				
	Bituminous Concrete Pavement	6,050	S.Y.	2.20	\$ 13,310
	Topsoiling, Rehandle and Placing	700	C.Y.	2.00	1,400
	Seeding - General	17	Acre	400.00	6,800
	Placing Stripping Material & Seeding, Borrow Area "C"	30	Acre	800.00	24,000
	Water Supply Well and Pump	1	Job	L.S.	<u>6,000</u>
	Sub-Total Dam				\$6,666,305
	Contingencies				<u>633,695</u>
	Total Dam Construction				\$7,300,000
	.2 Unwatering West Branch Reservoir				\$ 80,000
	Contingencies				<u>20,000</u>
	Total Unwatering West Branch Reservoir				\$ 100,000
	TOTAL DAM				<u>\$7,400,000</u>
08.	<u>Road</u>				
	Preparation of Site	1	Job	L.S.	\$ 5,000
	Unclassified Excavation	30,000	C.Y.	1.00	30,000
	Rock Excavation	7,700	C.Y.	4.00	30,800
	Rolled Gravel Base	5,300	C.Y.	1.50	7,950
	Cable Guide Railing	2,250	L.F.	3.00	6,750
	Drainage System	1	Job	L.S.	10,000
	Bituminous Concrete Pavement	6,300	S.Y.	2.20	13,860
	Topsoiling and Seeding	1	Job	L.S.	<u>10,000</u>
	Contingencies				\$ 114,360
	TOTAL ROAD				<u>20,640</u>
	TOTAL ROAD				\$ 135,000
14.	<u>Recreational Facilities</u>				
	Recreational Facilities	1	Job	L.S.	\$ 42,000
	Contingencies				<u>8,000</u>
	TOTAL RECREATIONAL FACILITIES				\$ 50,000

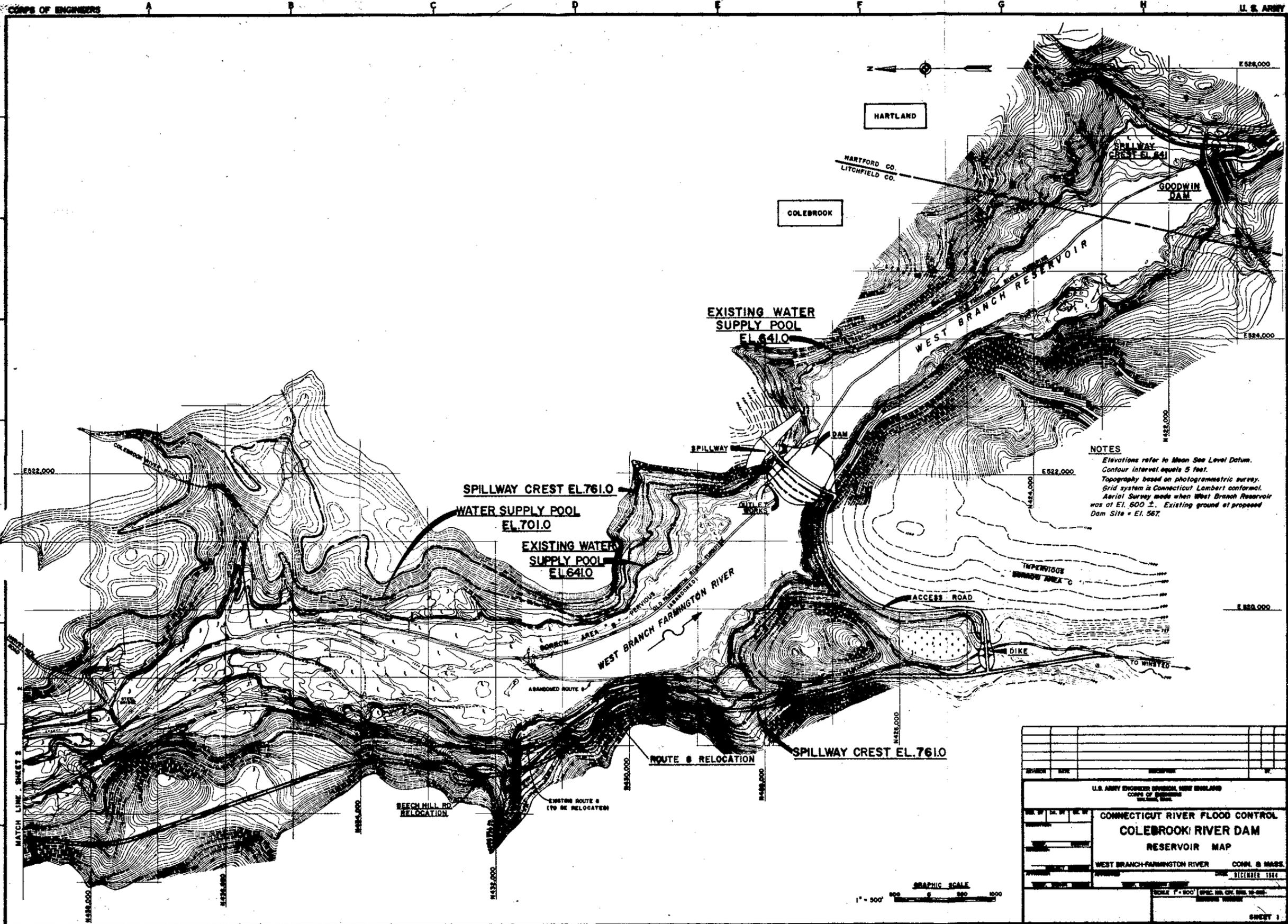
TABLE II (continued)

	<u>Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Estimated Amount</u>
19.	<u>Buildings, Grounds and Utilities</u>				
	Buildings, Grounds and Utilities	1	Job	L.S. \$	80,000
	Contingencies				<u>10,000</u>
	TOTAL BUILDINGS, GROUNDS AND UTILITIES			\$	90,000
20.	<u>Permanent Operating Equipment</u>				
	Permanent Operating Equipment			\$	35,000
	Contingencies				<u>5,000</u>
	TOTAL PERMANENT OPERATING EQUIPMENT			\$	40,000
30.	ENGINEERING AND DESIGN			\$	935,000
31.	SUPERVISION AND ADMINISTRATION			\$	<u>745,000</u>
	TOTAL PROJECT FIRST COST				\$15,000,000



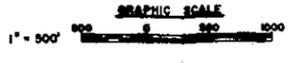
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CONNECTICUT RIVER FLOOD CONTROL FARMINGTON RIVER BASIN BASIN MAP	
FARMINGTON RIVER CONN. AND MASS. DATE: JULY 1954	
SCALE	1" = 1 MILE
SHEET	

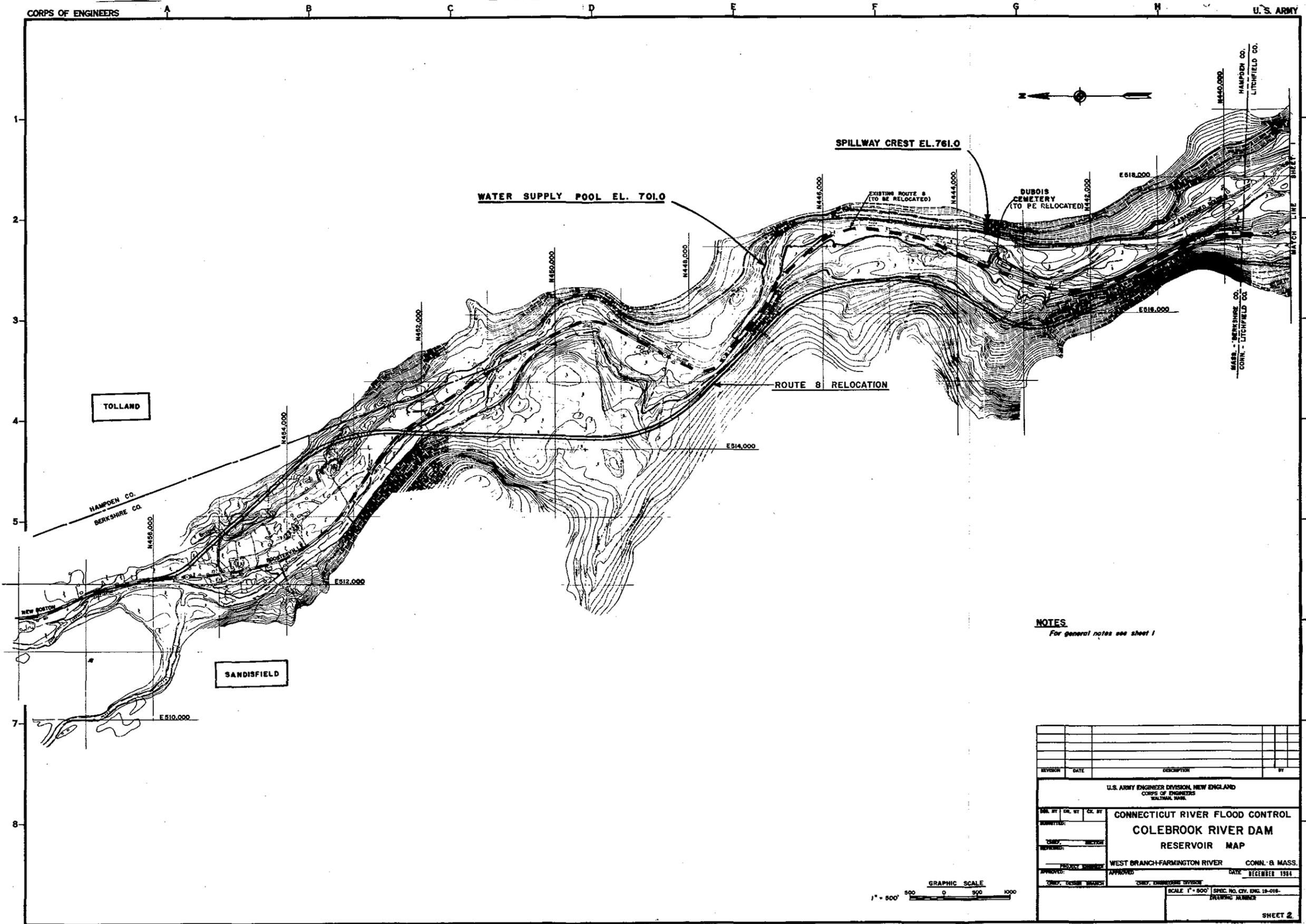




NOTES
 Elevations refer to Mean Sea Level Datum.
 Contour interval equals 5 feet.
 Topography based on photogrammetric survey.
 Grid system is Connecticut Lambert conformal.
 Aerial Survey made when West Branch Reservoir was at El. 600 ±. Existing ground at proposed Dam Site = El. 567.

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS Hartford, Conn.			
CONNECTICUT RIVER FLOOD CONTROL COLEBROOK RIVER DAM RESERVOIR MAP			
WEST BRANCH FARMINGTON RIVER		CONN. & MASS.	
DATE: DECEMBER 1954		SCALE: 1" = 500'	
SHEET 1			

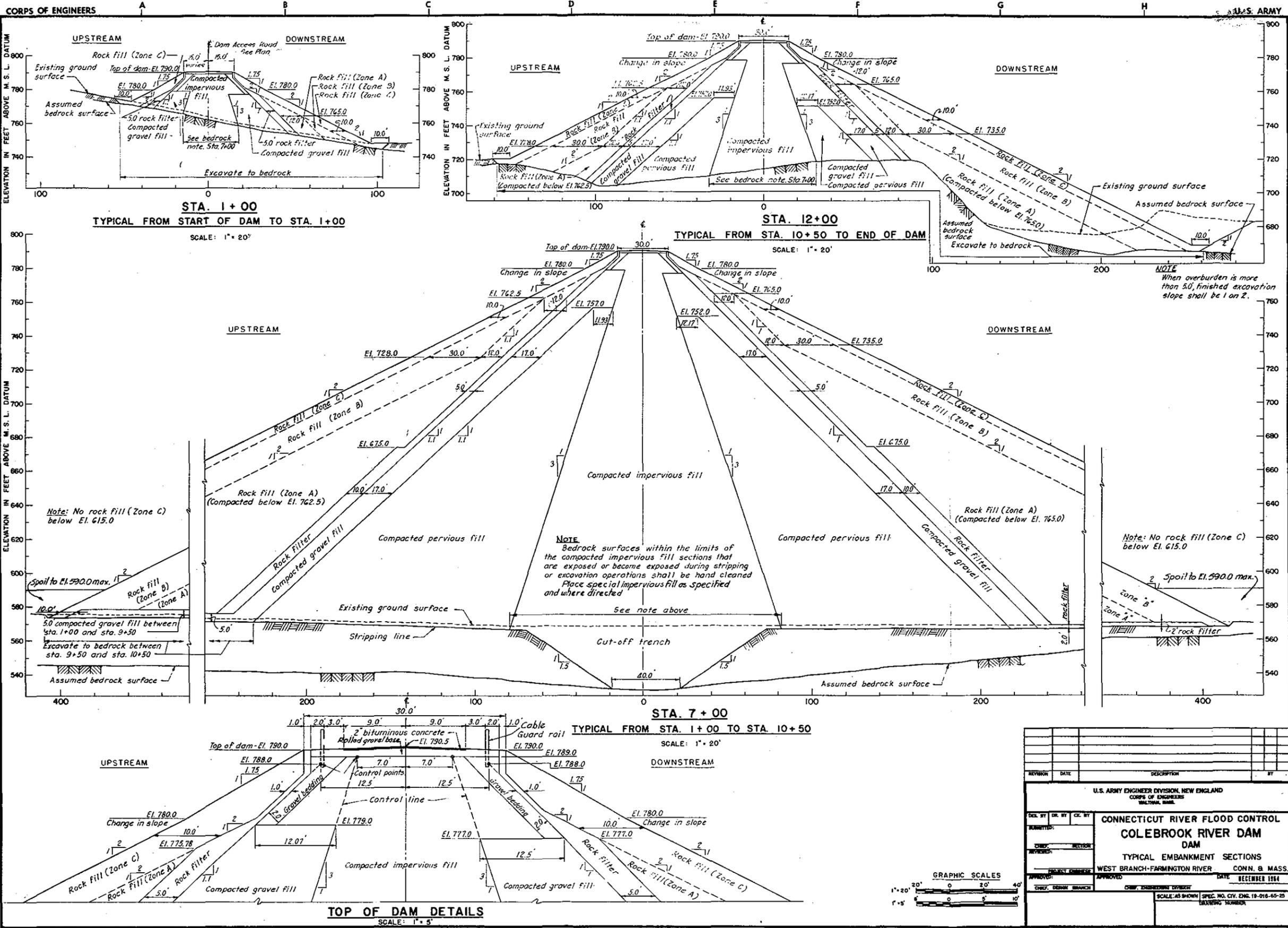




NOTES
 For general notes see sheet 1



REVISION	DATE	DESCRIPTION	BY
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.			
DESIGNED BY	DR. BY	COL. BY	
SUBMITTED:			CONNECTICUT RIVER FLOOD CONTROL COLEBROOK RIVER DAM RESERVOIR MAP
PROJECT NUMBER:			
APPROVED:			WEST BRANCH-FARMINGTON RIVER CONN. & MASS.
DATE:			DECEMBER 1964
SCALE 1" = 500'			SPEC. NO. CIV. ENGR. 19-016. EXCISES NUMBER
			SHEET 2.



REVISION	DATE	DESCRIPTION	BY

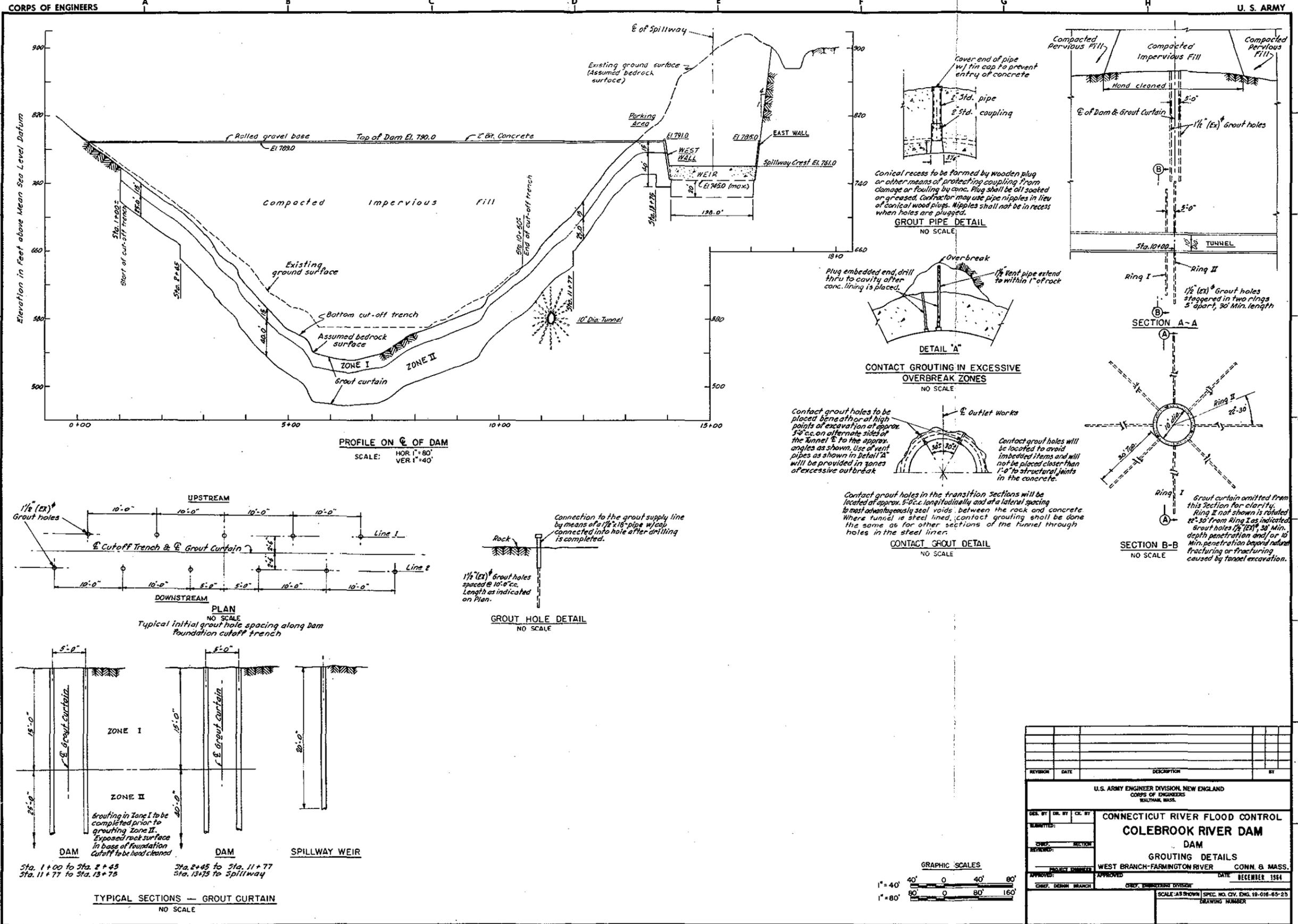
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

**CONNECTICUT RIVER FLOOD CONTROL
COLEBROOK RIVER DAM
DAM**

TYPICAL EMBANKMENT SECTIONS
WEST BRANCH-FARMINGTON RIVER CONN. & MASS.

APPROVED: _____ DATE: DECEMBER 1964

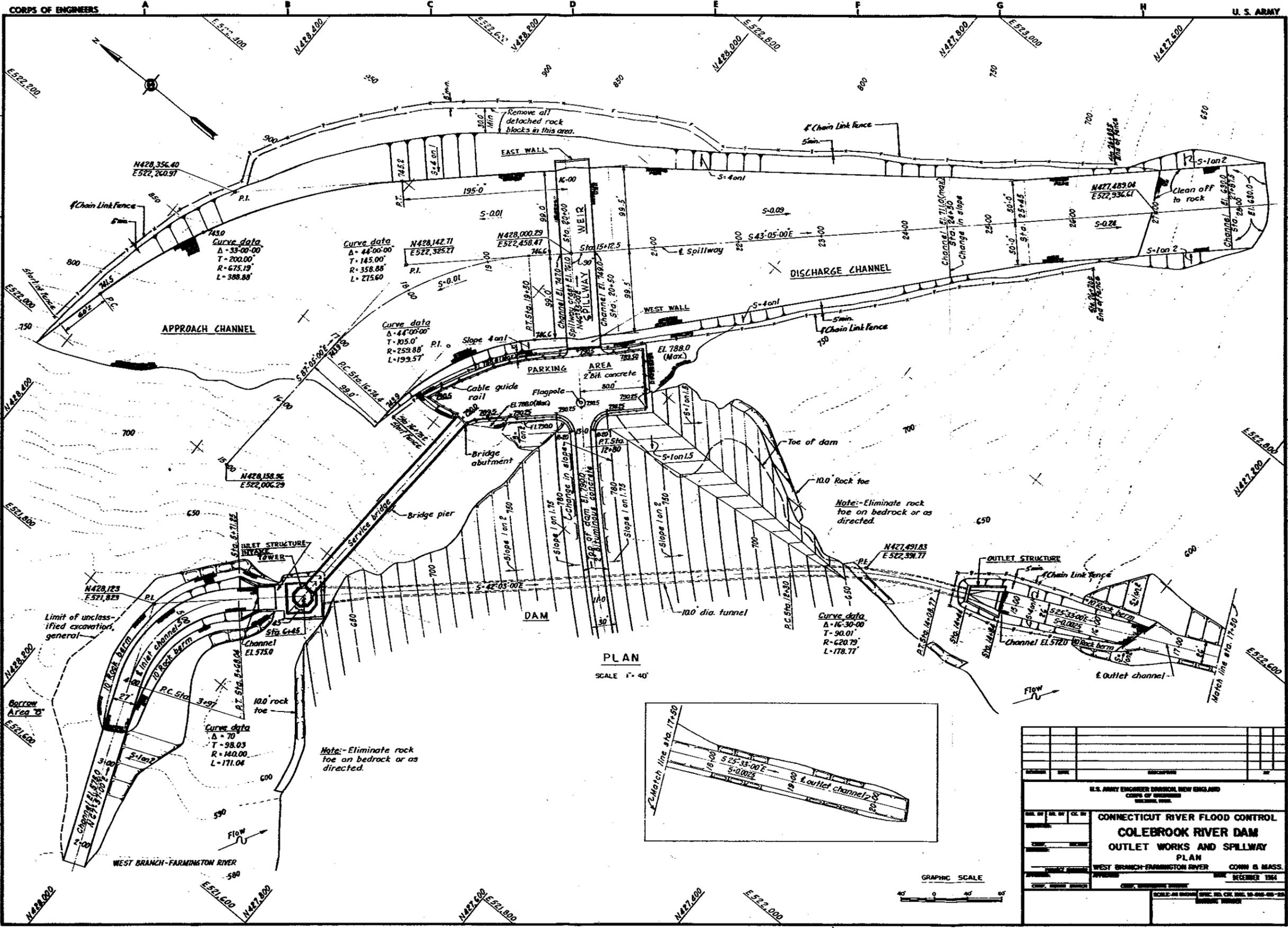
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DRAWING NUMBER



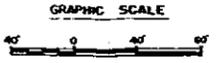
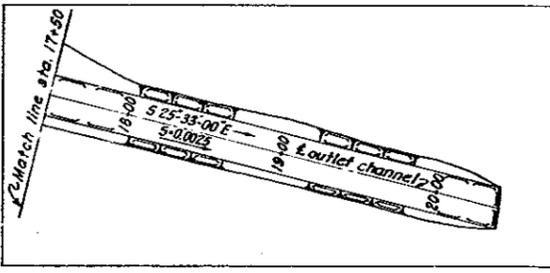
REVISION	DATE	DESCRIPTION	BY

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

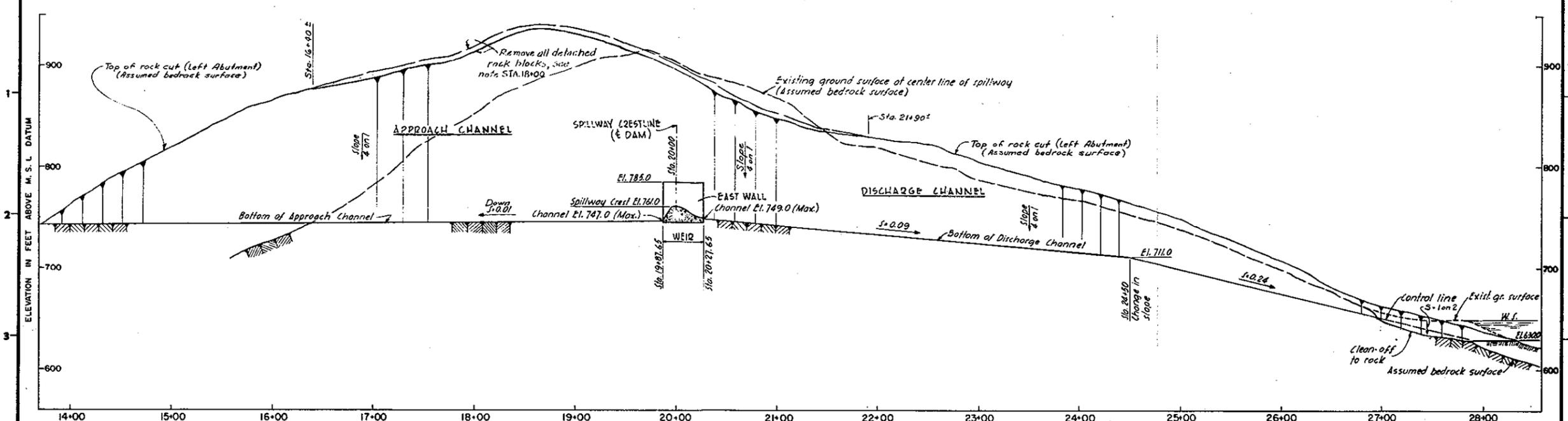
DES. BY: _____ DR. BY: _____ CK. BY: _____
 SUBMITTED: _____
 CHECKED: _____ SECTION: _____
 REVISIONS: _____
 PROJECT: WEST BRANCH-FARMINGTON RIVER CONN. & MASS.
 APPROVED: _____ DATE: DECEMBER 1964
 CHIEF, DESIGN BRANCH: _____ CHIEF, ENGINEERING DIVISION: _____
 SCALE: AS SHOWN SPEC. NO. CIV. ENG. 10-016-65-25
 DRAWING NUMBER: _____



PLAN
SCALE 1" = 40'

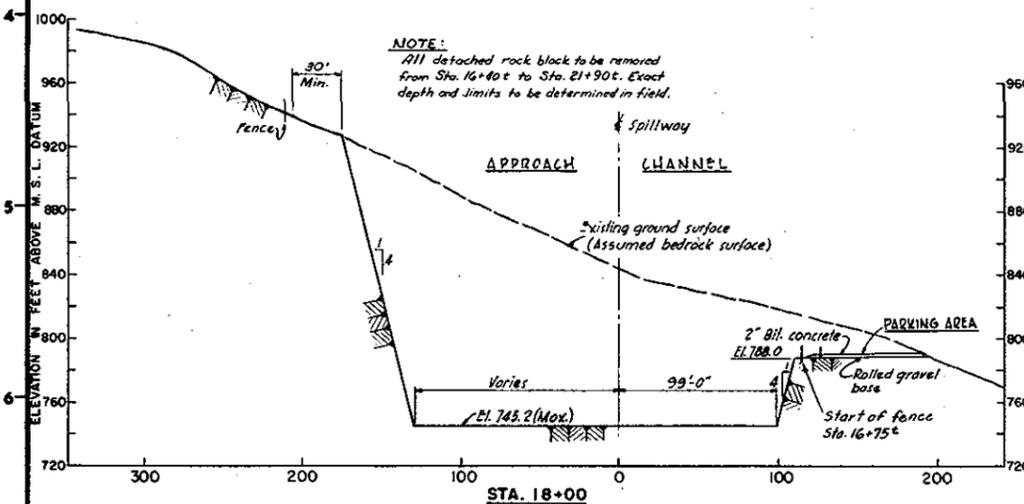


U.S. ARMY ENGINEER DISTRICT NEW ENGLAND CORPS OF ENGINEERS WATERWAYS DIVISION			
DESIGNED BY	DATE	APPROVED BY	DATE
CONNECTICUT RIVER FLOOD CONTROL COLEBROOK RIVER DAM OUTLET WORKS AND SPILLWAY PLAN			
WEST BRANCH-FARMINGTON RIVER		CONN & MASS.	
APPROVED		DATE	
		DECEMBER 1964	
SCALE: AS SHOWN (SEE 2ND, 3RD, 4TH, 5TH SHEETS OF THIS DRAWING)			

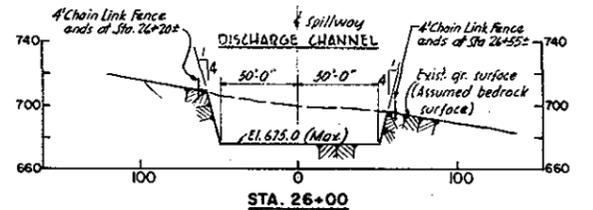


PROFILE ALONG CENTERLINE OF SPILLWAY CHANNEL

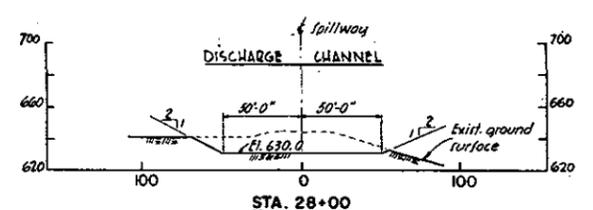
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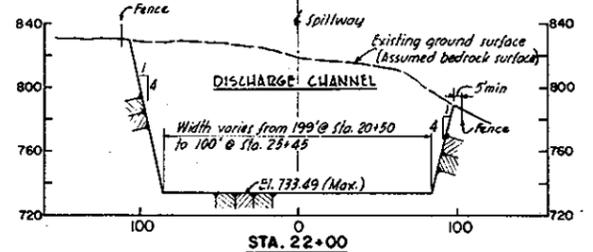
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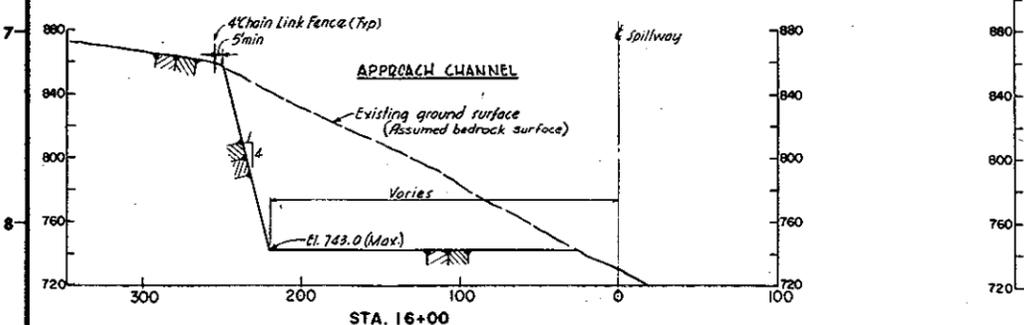
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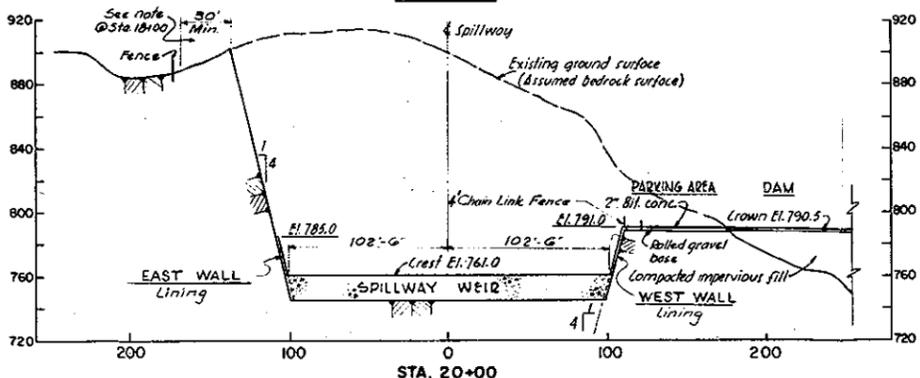
SECTION STA. 28+00



SECTION STA. 22+00

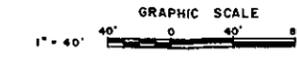


SECTION STA. 16+00



SECTION STA. 20+00

SECTIONS
SCALE: 1" = 40'



REVISION	DATE	DESCRIPTION	BY

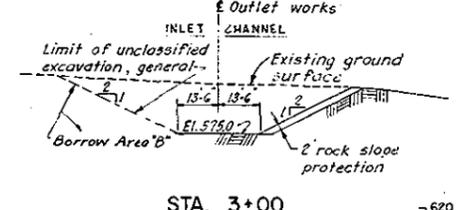
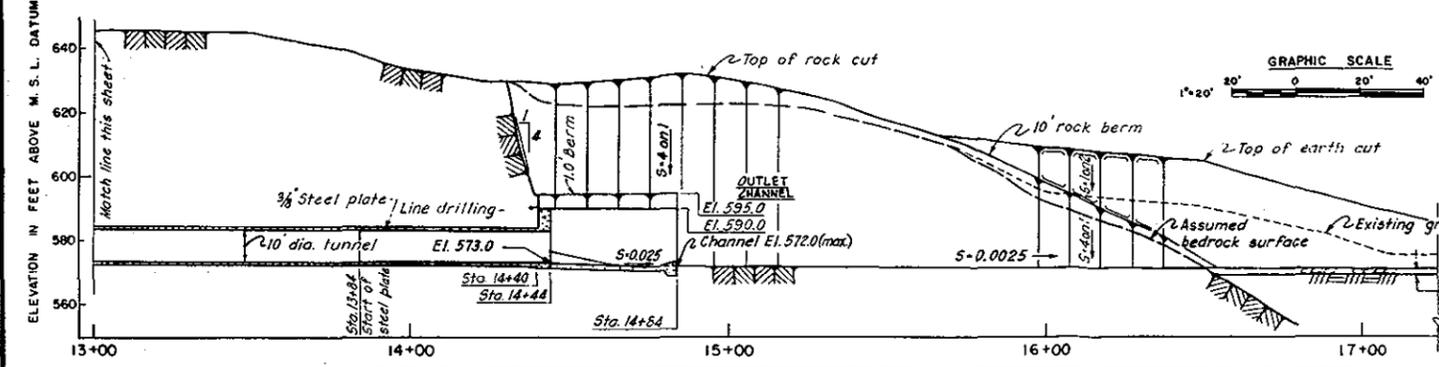
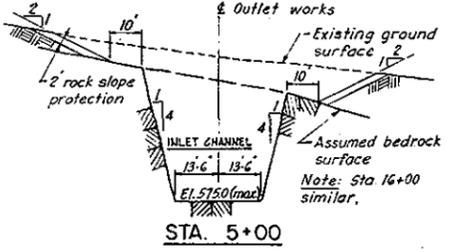
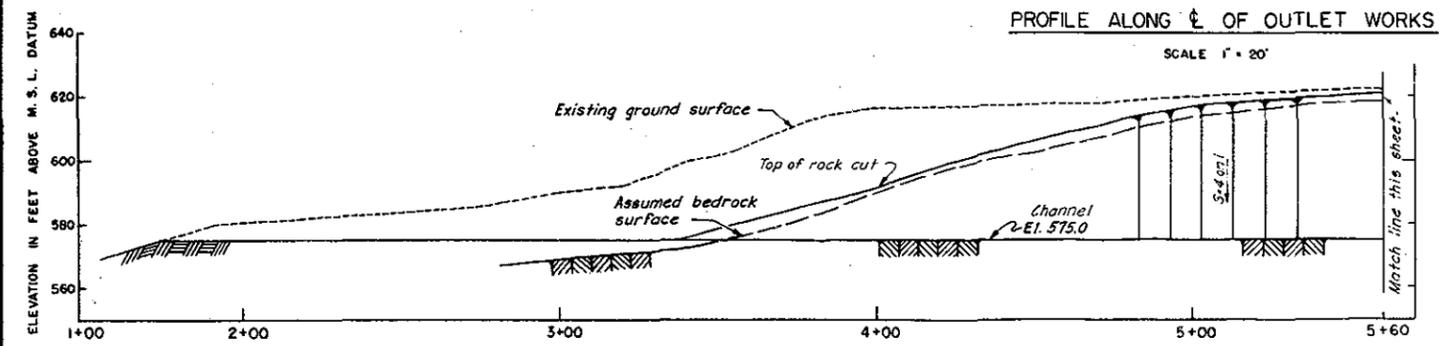
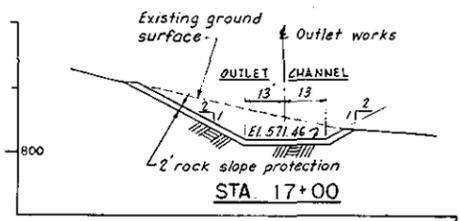
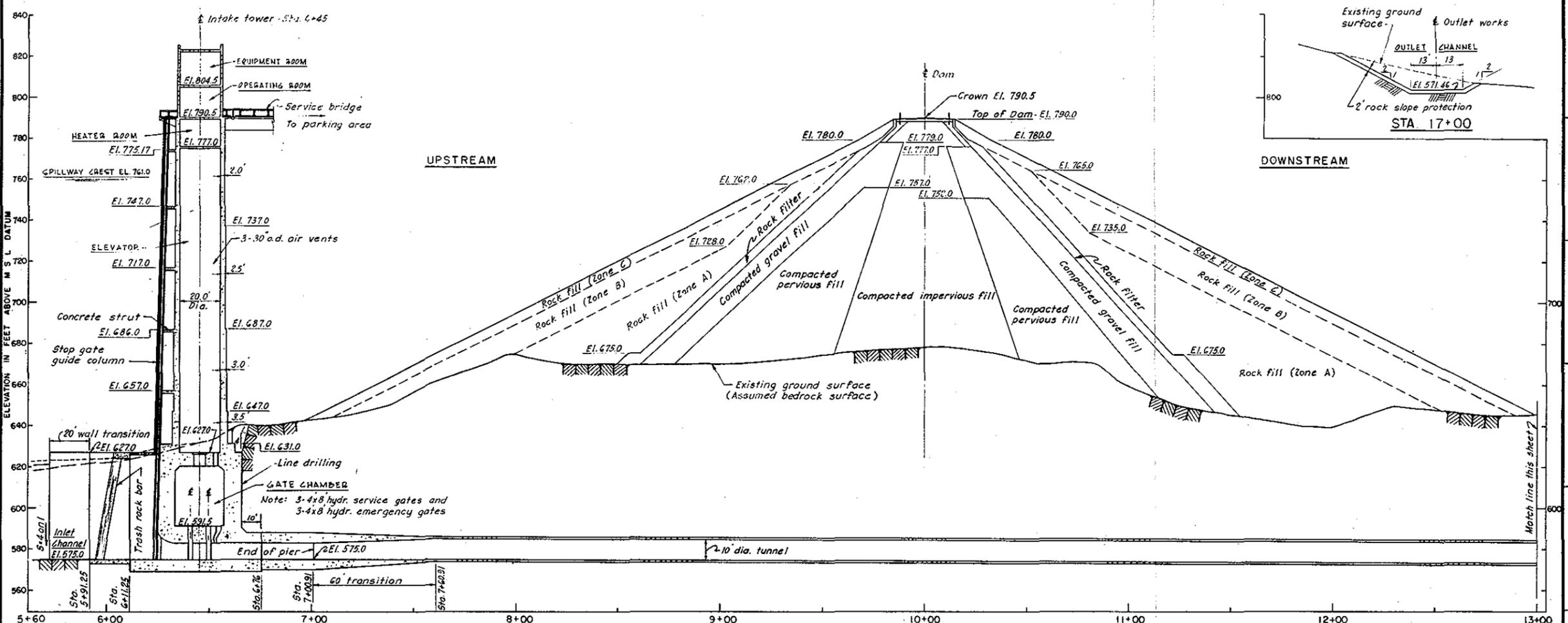
U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

CONNECTICUT RIVER FLOOD CONTROL
COLEBROOK RIVER DAM
SPILLWAY

PROFILE AND SECTIONS
WEST BRANCH-FARMINGTON RIVER CONN. & MASS.

DATE: DECEMBER 1954

SCALE: 1" = 40' SPEC. NO. CIV. ENG. 13-016-60-25
DRAWING NUMBER



REVISION	DATE	DESCRIPTION	BY

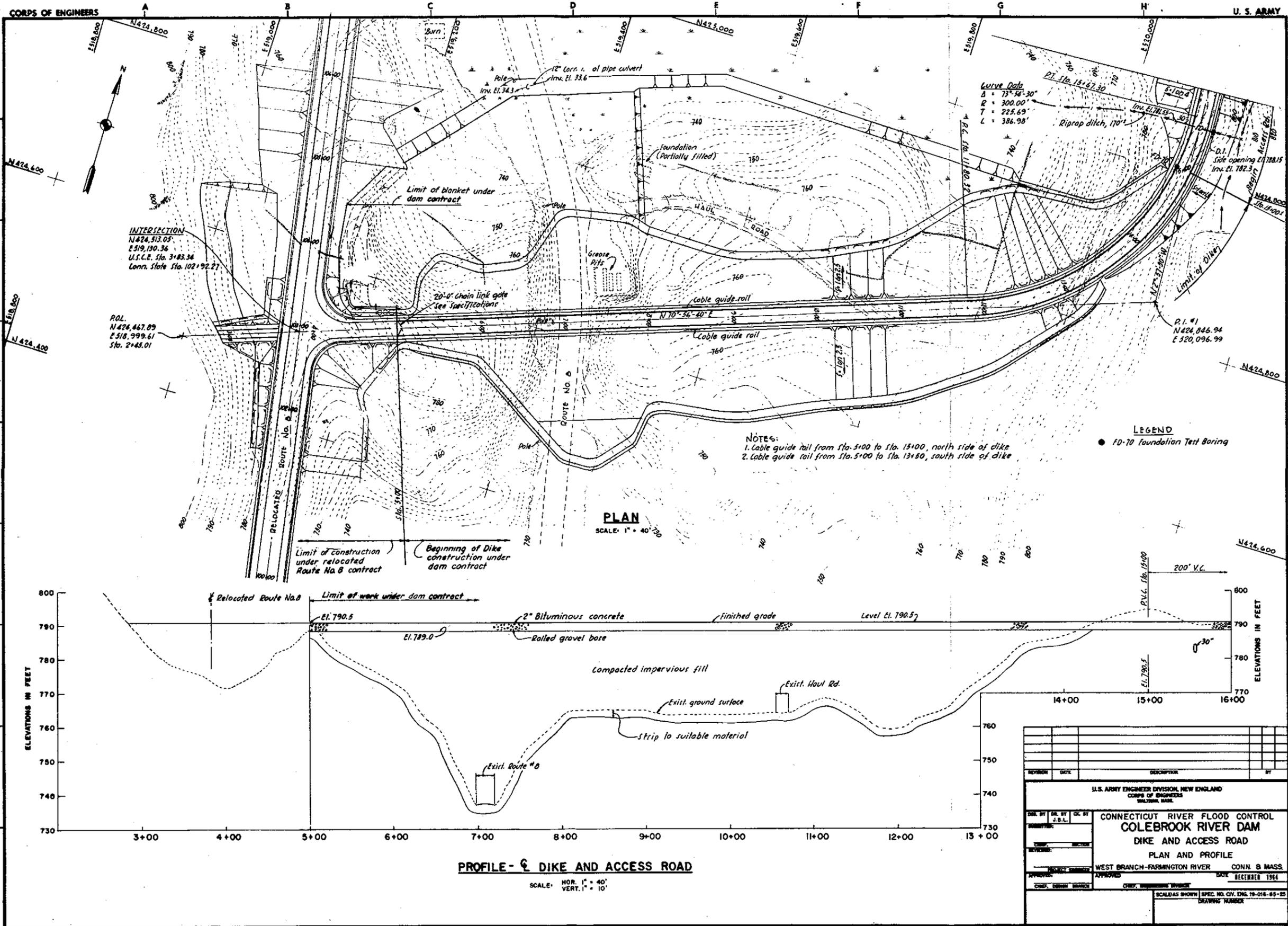
U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

**CONNECTICUT RIVER FLOOD CONTROL
COLEBROOK RIVER DAM
OUTLET WORKS**

PROFILE AND SECTIONS
WEST BRANCH-FARMINGTON RIVER CONN. & MASS.

DATE: DECEMBER 1964

SCALE: 1"=20' SPEC. NO. CIV. ENGR. 19-016-60-25
DRAWING NUMBER



REVISION	DATE	DESCRIPTION	BY

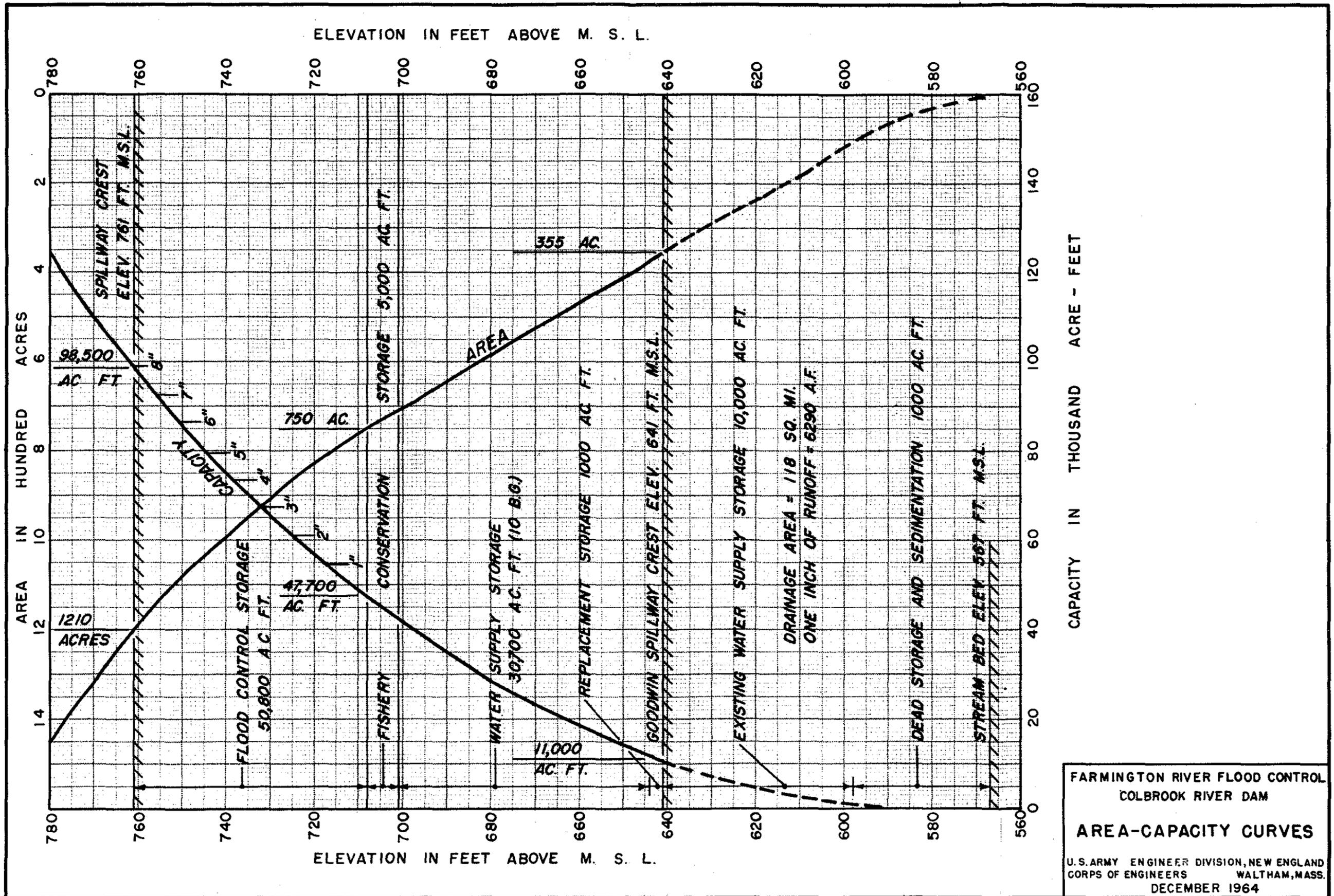
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

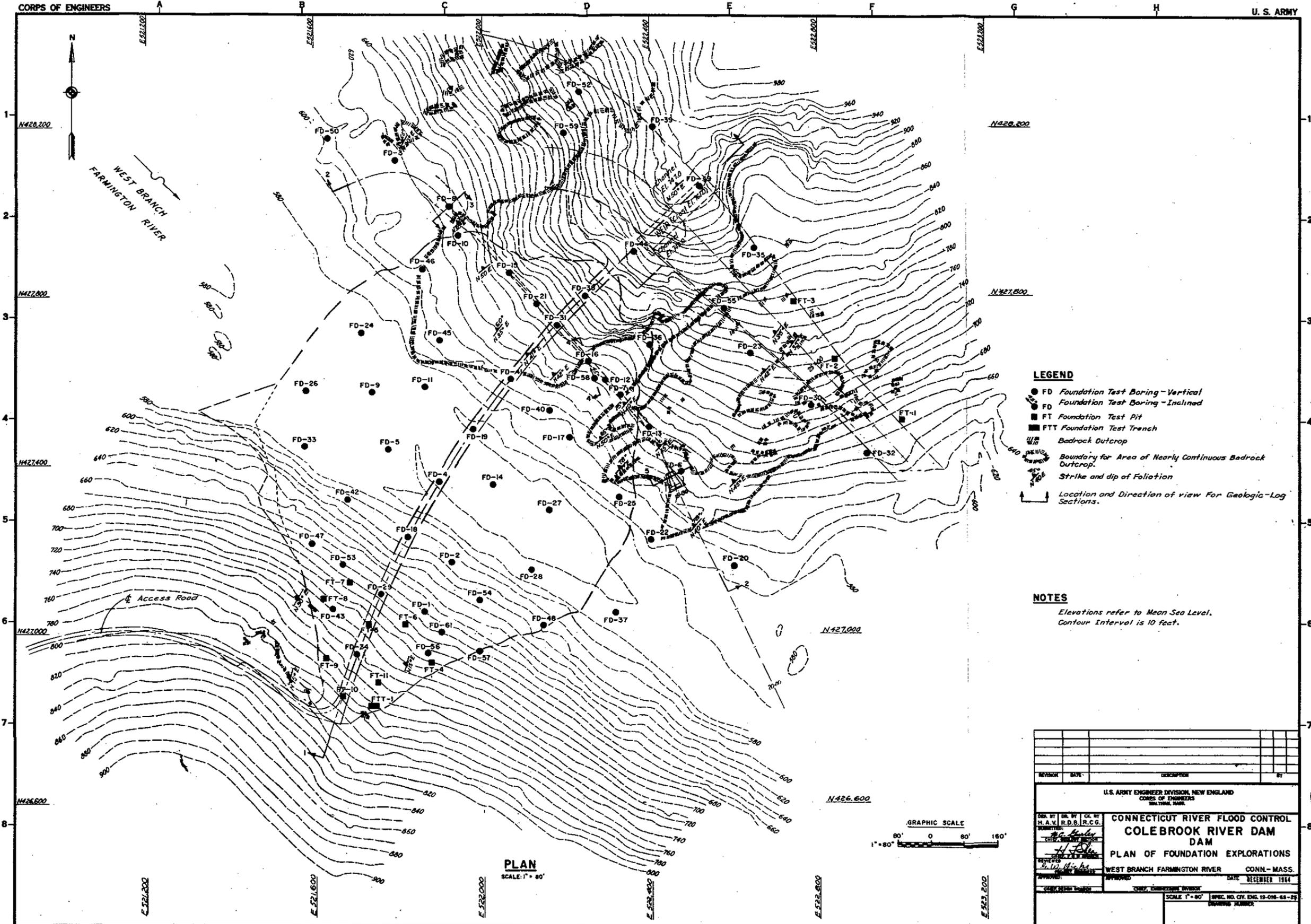
DESIGNED BY: J.B.L.
CHECKED BY: J.B.L.
DATE: DECEMBER 1964

**CONNECTICUT RIVER FLOOD CONTROL
COLEBROOK RIVER DAM
DIKE AND ACCESS ROAD
PLAN AND PROFILE**

WEST BRANCH-FARMINGTON RIVER CONN. & MASS.
DATE: DECEMBER 1964

SCALE: AS SHOWN SPEC. NO. CIV. ENGR. 19-016-65-25
DRAWING NUMBER





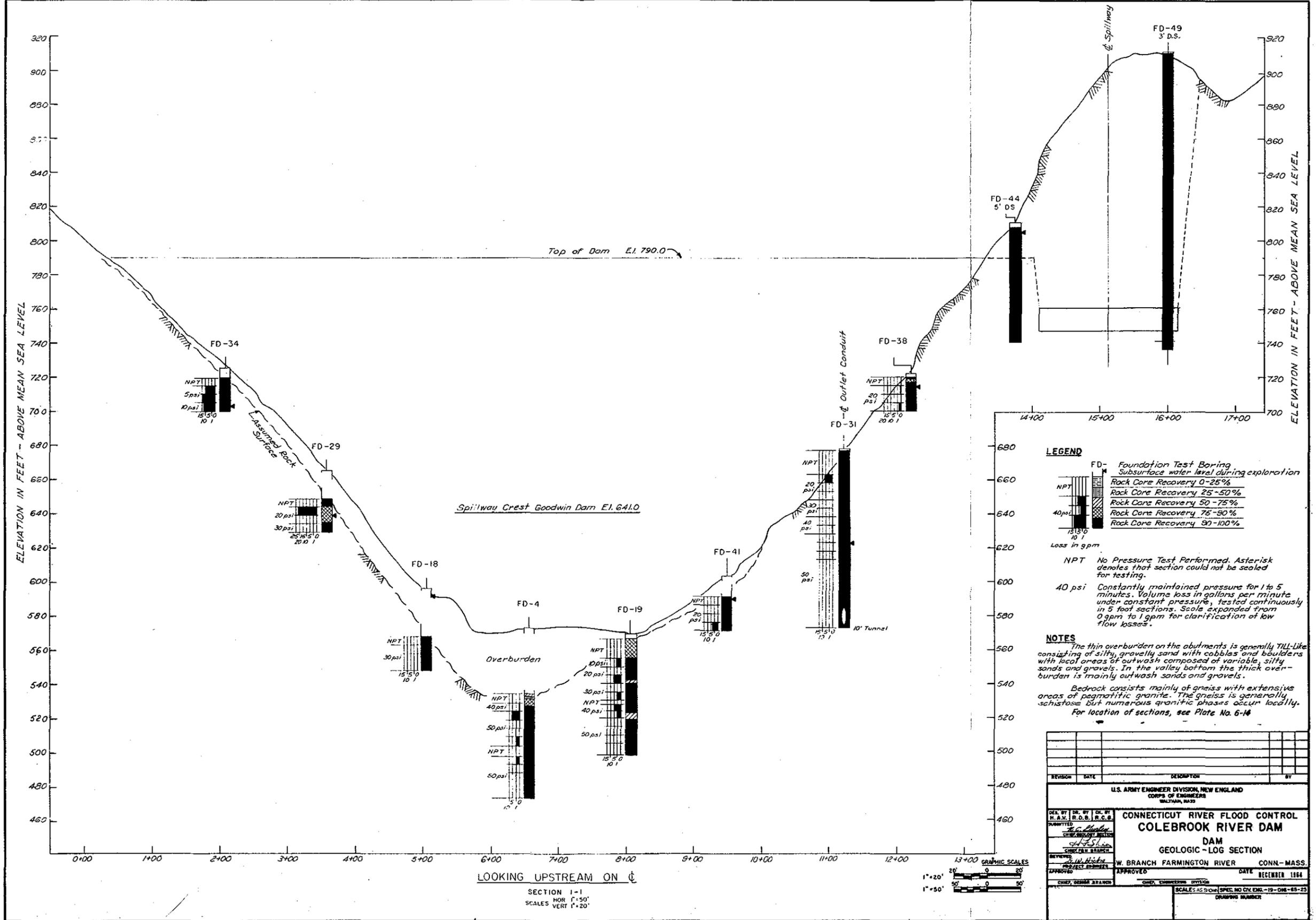
LEGEND

- FD Foundation Test Boring - Vertical
- FD Foundation Test Boring - Inclined
- FT Foundation Test Pit
- FTT Foundation Test Trench
- Bedrock Outcrop
- Boundary for Area of Nearly Continuous Bedrock Outcrop
- Strike and dip of Foliation
- Location and Direction of view For Geologic-Log Sections

NOTES

Elevations refer to Mean Sea Level.
Contour Interval is 10 feet.

REVISION	DATE	DESCRIPTION	BY
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS MILITARY, MASS.			
CONNECTICUT RIVER FLOOD CONTROL COLEBROOK RIVER DAM DAM			
PLAN OF FOUNDATION EXPLORATIONS			
DRAWN BY: H.A.V. R.D.S. R.C.G. CHECKED BY: [Signature] DESIGNED BY: [Signature]		WEST BRANCH FARMINGTON RIVER CONN.-MASS.	
APPROVED: [Signature] DATE: DECEMBER 1964		SPEC. NO. CIV. ENG. 13-016-63-25 DRAWING NUMBER	



LEGEND

FD- Foundation Test Boring
 Subsurface water level during exploration

NPT No Pressure Test Performed. Asterisk denotes that section could not be sealed for testing.

40 psi Constantly maintained pressure for 1 to 5 minutes. Volume loss in gallons per minute under constant pressure, tested continuously in 5 foot sections. Scale expanded from 0 gpm to 1 gpm for clarification of low flow losses.

Rock Core Recovery 0-25%
 Rock Core Recovery 25-50%
 Rock Core Recovery 50-75%
 Rock Core Recovery 75-90%
 Rock Core Recovery 90-100%

NOTES

The thin overburden on the abutments is generally till-like consisting of silty, gravelly sand with cobbles and boulders with local areas of outwash composed of variable, silty sands and gravels. In the valley bottom the thick overburden is mainly outwash sands and gravels.

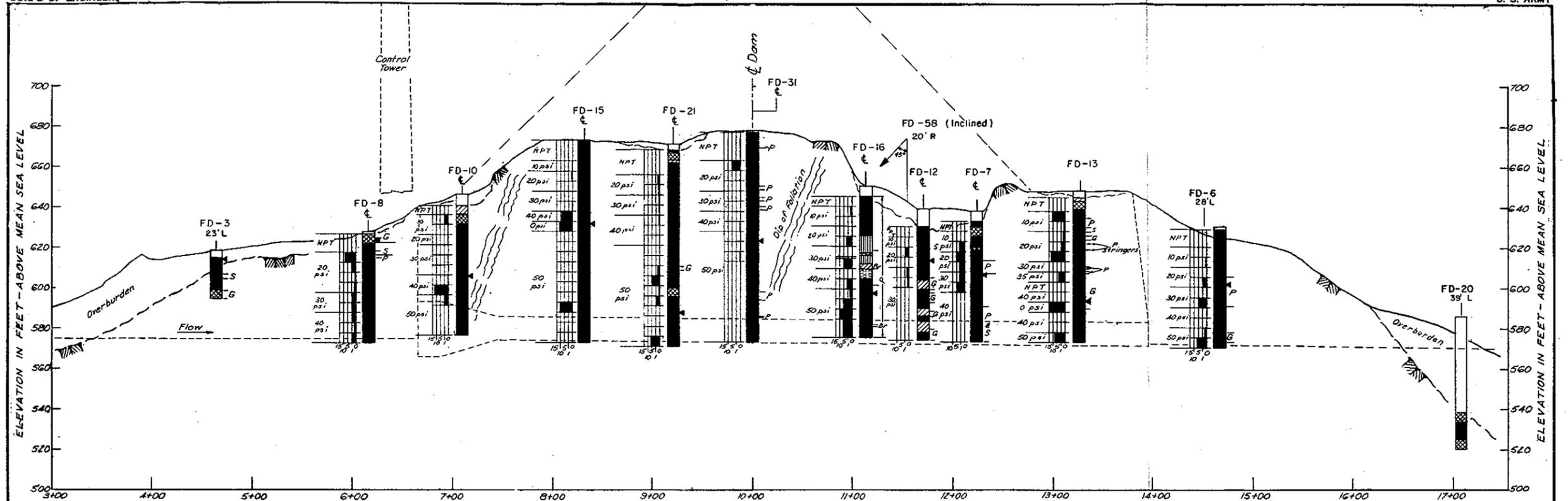
Bedrock consists mainly of gneiss with extensive areas of pegmatitic granite. The gneiss is generally schistose but numerous granitic phases occur locally. For location of sections, see Plate No. 6-14

REVISION	DATE	DESCRIPTION	BY

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

DESIGNED BY: H. A. W. (R.D.B.)
 DRAWN BY: J. C. [Signature]
 CHECKED BY: [Signature]
 REVIEWED BY: W. Branch Farmington River
 PROJECT ENGINEER: [Signature]
 APPROVED: [Signature] DATE: DECEMBER 1964

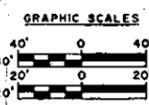
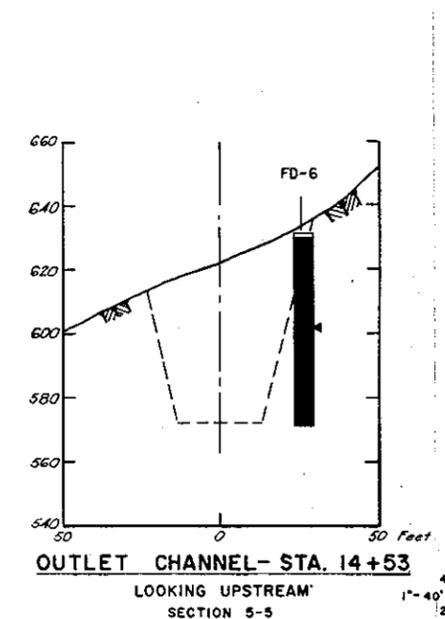
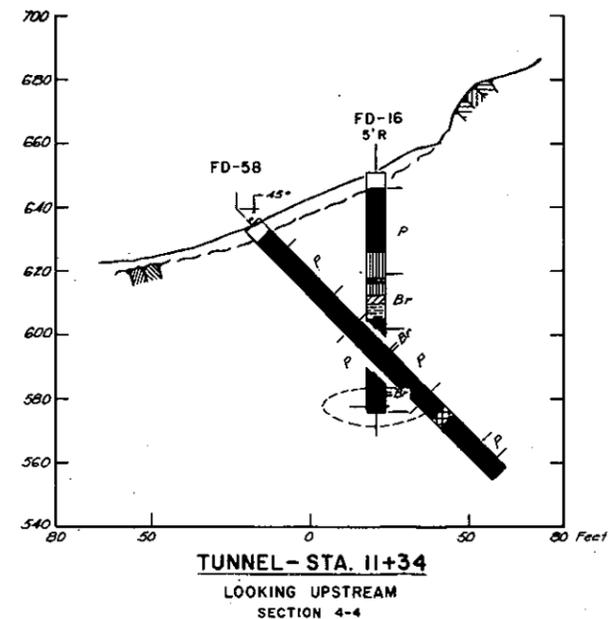
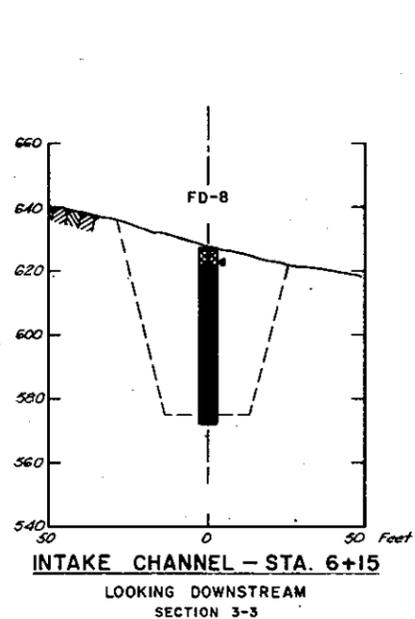
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CENTER LINE-OUTLET WORKS
SECTION 2-2

SYMBOLS FOR ROCK TYPE
 G - Granite, fine-grained
 P - Granite, Pegmatite
 S - Schist
 Br - Breccia
 Where not otherwise designated the rock is gneiss.

NOTES:
 For location of section, see Plans No. 6-14.



REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
 CORPS OF ENGINEERS
 BALTHAM, MASS.

DESIGNED BY: H.A.V.L.H.I.R.C.G.
 DRAWN BY: [Signature]
 CHECKED BY: [Signature]
 REVIEWED BY: [Signature]
 APPROVED BY: [Signature]

**CONNECTICUT RIVER FLOOD CONTROL
 COLEBROOK RIVER DAM
 OUTLET WORKS**

**GEOLOGIC-LOG SECTIONS
 WEST BRANCH FARMINGTON RIVER
 CONN.-MASS.**

DATE: DECEMBER 1954

SCALE AS SHOWN (SPEC. NO. CIV. ENG. -19-DHS-65-25)
 DRAWING NUMBER

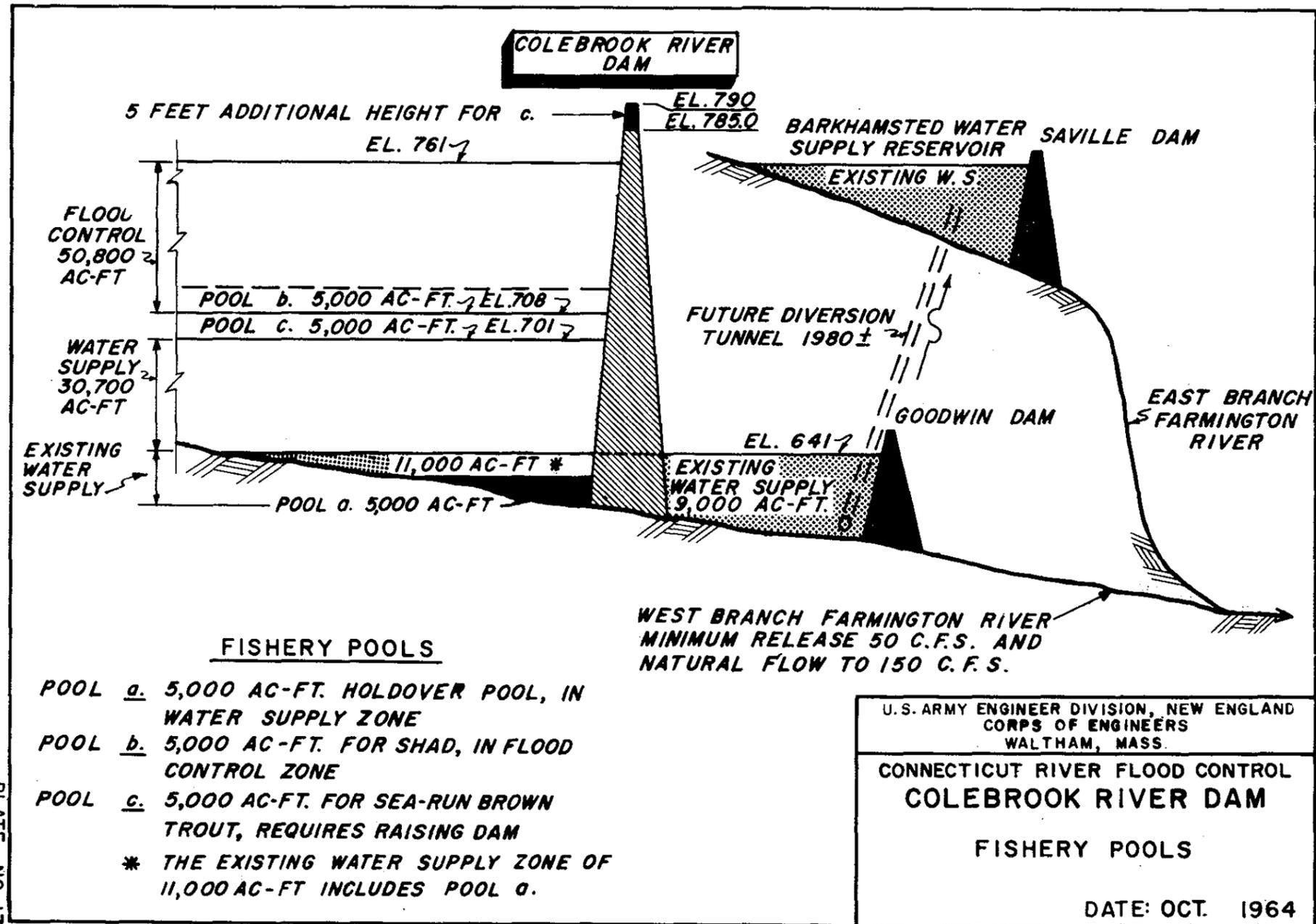


PLATE NO. 17

APPENDIX A

LETTERS OF COMMENT AND CONCURRENCE

APPENDIX A

LETTERS OF COMMENTS AND CONCURRENCE

CONTENTS

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LIST OF EXHIBITS

<u>Exhibit No.</u>	<u>Agency</u>	<u>Letter Dated</u>
1	U.S.Fish and Wildlife Service	12 Feb. 1964
2	U.S.Fish and Wildlife Service	1 Jun. 1964
3	U.S.Fish and Wildlife Service	27 Aug. 1964
4	U.S.Fish and Wildlife Service	9 Dec. 1964
5	Connecticut Board of Fisheries and Game	14 Dec. 1964
6	Connecticut Park and Forest Commission	4 Dec. 1964
7	U.S.Public Health Service	10 Jan. 1964
8	Federal Power Commission	18 Dec. 1963
9	Federal Power Commission	17 Aug. 1964
10	Massachusetts Water Resources Commission	1 Dec. 1964
11	Massachusetts Water Resources Commission	20 Jan. 1965
12	The Metropolitan District	3 Nov. 1964
13	Farmington River Watershed Association	30 Oct. 1964
14	Farmington River Watershed Association	17 Dec. 1964
15	Travelers Research Center	12 Nov. 1964
16	Allied Connecticut Towns	10 Apr. 1964
17	Allied Connecticut Towns, Newspaper Clipping	3 Jan. 1965

APPENDIX A

LETTERS OF COMMENT AND CONCURRENCE

1. Letters of Comment and Concurrence. - Pursuant to Paragraph 3 of OCE 3rd Indorsement, dated 2 October 1964, Subject: "Report on Provision of Fishery Storage in Colebrook River Dam and Reservoir, Farmington River, Connecticut River Basin, Connecticut and Massachusetts", comments were requested from all State and local interests concerned. A pamphlet describing the project and the proposed fisheries pools was furnished these agencies with a request for comment. The more important comments are included herein as Exhibits. Agencies which commented briefly or which did not reply are covered in the following sub-paragraphs:

a. Public Health Service. - By letter of 23 November 1964, the U. S. Public Health Service informed us that "we have no additional comments to make concerning this project at this time." Their comments, as included in the original General Design Memorandum, are reproduced as Exhibit 7.

b. Connecticut State Highway Department. - By letter of 10 November 1964, the Connecticut State Highway Department stated that "There is no objection to the provision of these fishery pools at Colebrook River Reservoir insofar as their effect on Relocated Route 8 is concerned."

c. Connecticut State Department of Health. - The Connecticut State Department of Health expressed their concern over the protection for the drinking water supply. They were informed of our plans in this regard and promised that we would consult with them in the preparation of the Master Plan for Reservoir Management.

d. Hogback Recreation Commission. - This commission is responsible for regulation of boating, hunting, and fishing at the West Branch Reservoir. The membership is made up of representatives of the Metropolitan District, State Department of Health, State Board of Fisheries and Game, and the Towns of Colebrook, Hartland, Barkhamsted, and New Hartford. Informal information indicates that this Commission has not met for many months. No reply has been received from the Commission. Comments have been received from the State Health Department, State Board of Fisheries and Game, and the Metropolitan District, which agencies are represented on the Commission. Mr. Luther B. Martin, Jr., Chairman of the Commission, was responsible for the 1963 legislation which eliminated the requirement of State law that the Metropolitan District must pass natural flows up to 150 c.f.s. at the Goodwin Dam. It is understood that he was under the impression that this action would result in the maintenance of higher water levels at the West Branch Reservoir.

e. Allied Connecticut Towns. - Informal information and a newspaper report indicate that the Allied Connecticut Towns appointed a committee to meet with the State Board of Fisheries and Game to negotiate toward an agreement on the use of flows between 50 and 150 c.f.s. By letter of 10 April 1964 to the Connecticut Board of Fisheries and Game (Exhibit 16), Judge Hadleigh M. Howd, President of the Allied Connecticut Towns, indicated a sympathetic viewpoint. No recent comment has been received. The clipping from the Hartford Courant of 3 January 1965 is reproduced as Exhibit 17.

f. Farmington River Power Company. - Mr. Robert Tolles, President of the Farmington River Power Company, which owns and operates the dam at Rainbow, declined to comment at this time pending a review of the total picture. This review is in progress. He did indicate that they have no quarrel with the Corps of Engineers or with the three fisheries pools.

g. Collins Company. - Mr. Clair Elston, President of the Collins Company, which owns and operates the two dams at Collinsville, said there is no particular objection that they see at this time, but they desire the water rights to be fully worked out before making any commitments or written comment.



UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

59 TEMPLE PLACE
BOSTON 11, MASSACHUSETTS

February 12, 1964

Division Engineer
U.S. Army Engineer Division, N.E.
Corps of Engineers
424 Trapelo Road
Waltham 54, Mass.

Dear Sir:

This is our conservation and development report on fish and wildlife resources in relation to the Colebrook River Reservoir, Connecticut. It was prepared under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended, 16 U.S.C. 661-666 inclusive), in cooperation with the Connecticut State Board of Fisheries and Game and the Massachusetts Division of Fisheries and Game. The Massachusetts Division of Fisheries and Game signified its concurrence in its letter of December 23, 1963. This report was coordinated with the Bureau of Commercial Fisheries and also represents its views. The Connecticut Board of Fisheries and Game has indicated that they feel that satisfactory mitigation of fishery losses can only be accomplished by inclusion of an independent fishery pool in Colebrook Reservoir and not through utilization of a holdover storage pool.

According to information from your agency and others, Colebrook River Reservoir was authorized by the Flood Control Act of 1960 for flood control and water supply storage. The Metropolitan District of Hartford County will participate in the project and utilize the water storage. The reservoir will be located on the West Branch of the Farmington River in the Town of Colebrook, Litchfield County. It is our understanding that the dam site is located about one and one-half miles upstream from Goodwin Dam (Hogback Reservoir). Colebrook River Dam will be located in the 560-acre Hogback Reservoir pool, owned by the Metropolitan District. The upper end of the Colebrook River Reservoir will extend into Massachusetts.

The reservoir site is in a narrow, steep-sided valley with heavily forested slopes. The following is our understanding of the engineering features of the project. The spillway crest of the Colebrook River Dam will be at elevation 756 feet, m.s.l. The reservoir will provide flood storage of 50,800 acre-feet and water supply storage of 30,700 acre-feet. The maximum elevation of the 705-acre water supply pool will be at elevation 700, which is 133 feet above the stream bed.

EXHIBIT 1-1

Most of the land in Connecticut and some land in Massachusetts in the vicinity of the Colebrook River project is already owned by the Metropolitan District in connection with the Hogback Reservoir. Lands needed for the Colebrook River project will be obtained through an agreement with the Metropolitan District. About 175 additional acres of land in both States will be acquired for the project which, at spillway elevation, will encompass approximately 1150 acres.

The water supply pool of Colebrook Reservoir will be operated as required by the Metropolitan District Commission. During the first ten years of operation the water supply pool will be used to satisfy commitments of the M.D.C. to downstream riparian owners who would otherwise be adversely affected by diversion of water from other segments of the watershed for water supply purposes. These riparian owners are primarily interested in the production of hydroelectric power used in their manufacturing operations. These are primarily the Collins Company which operates Collinsville Dam, 16 miles below Goodwin Dam, and the Farmington River Power Company which operates Rainbow Dam about eight miles above the confluence of the Farmington and Connecticut Rivers. Only a minimum release of 50 c.f.s. is required by State law but under agreement with these riparian owners and the Allied Connecticut Towns, Inc., no storage will take place until releases reach 150 c.f.s.

By 1975 or soon thereafter, a tunnel will have been completed from Hogback Reservoir to Barkhamstead Reservoir, and the M.D.C. will proceed to acquire downstream riparian rights either through negotiation or condemnation. At this time water will be shunted to Barkhamstead Reservoir and into the water supply system. With acquisition of riparian rights present riparian releases will cease and eventually only the minimum 50 c.f.s. release at Colebrook Dam will be required. Aside from occasional overflows in the spring freshet period it appears that flows below Colebrook River Dam will eventually be limited to 50 c.f.s. most of the year with flows dropping to 50 c.f.s. for extended periods in extremely dry years. Even this 50 c.f.s. would still be subject to reregulation by riparian owners since this legal minimum could not be bought or condemned by the M.D.C. At this time, around 1975 or soon thereafter, it is expected that both Hogback and Colebrook Reservoirs could be drastically drawn down each year. It is our understanding that the Massachusetts Water Resources Commission gave its approval to the Colebrook River Reservoir project with the understanding that the proposed reservoir would be operated in such a manner as to preclude the need for drawing down Otis Reservoir, Massachusetts, during the recreational period from June 1 to October 1 each year.

Under present conditions there are significant fishing opportunities downstream from Hogback Reservoir mainly of a "put-and-take" nature. Table 1 gives pertinent data on the various reaches below Hogback showing a current use of 51,500 fisherman days annually. At a recreational value of \$3.00 per fisherman day, the total value of the estimated fishery in the river was \$154,000 in 1962.

Table 1. Pertinent data, fishery downstream from Goodwin Dam

<u>Reach</u>	<u>Est. Miles in Reach</u>	<u>No. of Trout Stocked in 1962</u>	<u>Estimated No. of Fisherman-days ^{2/}</u>
Goodwin Dam to Collinsville	16.0	20,270	30,400
Collinsville to Unionville	3.5	6,570	9,800
Farmington and Tarriffville-Spoonville	<u>1/</u>	7,590	11,300
		<u>34,430</u>	<u>51,500</u>

1/ Miles not estimated since trout are stocked at certain points and not all of this reach is considered trout water.

2/ Considering that 75% of stocked trout are taken at the rate of .5 fish per trip. (No creel census data are available.)

With increasing demands, additional stocking in the future will bring the average annual use of the river between Hogback Dam and Rainbow Dam to 65,000 fisherman days. Hogback Reservoir will provide fishing for chain pickerel and for stocked trout. Extensive summer drawdowns inhibit the fishery utilization which will average 3,000 man days over the life of the project. In the upstream segment of the Colebrook Reservoir site there are approximately 1½ miles of trout stream which will furnish 75 fisherman days annually. Downstream from Rainbow Dam there is a sport fishery for shad amounting to 2,000 fisherman days annually. This is limited by releases from Rainbow Dam which are not large or sustained enough to attract the shad into the fishable segment of the river at all times during the spawning period. It is further limited by the lack of a fishway in Rainbow Dam which would allow shad to utilize upstream areas for spawning and nursery habitat. The State Legislature appropriated money in 1963 for planning such a fishway but it would still be necessary to secure water rights to sufficient stream flow and storage to permit releases for fishway operation and maintenance of suitable flows below Rainbow Dam during the shad spawning period. Pollution in the basin is scheduled to be corrected by 1966 removing any limitations caused by water quality problems.

There is only a minor amount of hunting opportunity for whitetail deer, varying hare, ruffed grouse, and gray squirrels involved in the project area.

During the first ten years of project operation the downstream fishery will not be adversely affected, in fact there may be some benefit to the trout fishery as riparian requirements are satisfied by releases from Hogback rather than down the East Branch. Fishing opportunity in the remaining portion of Hogback Reservoir and in Colebrook Reservoir, based mainly on stocked trout, will amount to 4,000 man days annually, while the upstream fishery will be 25 man days.

Eventually, however, as riparian rights are acquired, the downstream trout fishery will be reduced from 65,000 to 15,000 man days annually, the fishery in the reservoirs will be reduced from 4,000 to 2,000 man days, and the upstream fishery will remain at the reduced figure of 25 man days. Downstream from Rainbow Dam the amount and duration of flows will be further reduced and the shad fishery will drop from 2,000 to 1,000 man days annually. Elimination of drawdown during the summer months in Otis Reservoir will convert these waters from marginal trout waters to a fair trout pond with the opportunity for additional fishing for stocked trout. This is not, however, a direct effect of the project.

From around 1975 through the life of the project there will be an annual loss of 53,000 fisherman days annually compared with the resource potential without the project.

Wildlife resources will suffer no significant losses.

The construction of Colebrook Reservoir will make it possible to store flows which now escape to the ocean and ultimately to divert these so that they will no longer be available in the reaches of Farmington River downstream from Goodwin Dam.

Since the mitigation of the very serious fishery losses this will entail may involve the provision of additional capacity in Colebrook Reservoir, it must be considered now along with other aspects of project construction and operation.

It is our understanding that approximately 5,000 acre-feet of storage could be provided at reasonable cost and could provide a permanent pool of some 240 acres with an average depth of about 20 feet and a maximum depth of 48 feet. The knowledge that year-round trout habitat would be maintained would encourage heavy spring stocking when the reservoir was close to maximum pool. There would not be the present reluctance resulting from the risk of trout losses due to drawdowns later in the season, which would leave a shallow pond too warm to support trout. With adequate access, parking, and boat launching facilities, this would replace the major part of the fishery lost downstream. To provide for a fishery of this magnitude in Colebrook Reservoir would require parking for 350 cars and two launching ramps, in addition to parking and launching for other recreational pursuits. Access should be provided from the Massachusetts portion of the shoreline where the relocation of Route 8 would provide the opportunity to use the abandoned section for access and boat launching. There will still be a loss of some 5,000 fisherman days annually, the loss to the shad fishery would not be mitigated and would form part of this remaining loss.

Under the current water allocations, however, and under M.D.C. plans, the flows available for storage at the Colebrook site would not be sufficient to bring downstream flows to a level which could support a sizeable fishery there for stocked trout, nor would it provide flows necessary for the development of anadromous fisheries.

We have been advised, however, by Commissioner Joseph N. Gill of the Connecticut Department of Agriculture, Conservation, and Natural Resources that it is their intention to request the Connecticut Legislature to allot for storage for wildlife and recreational use those flows in excess of the 50 c.f.s. continuous release required by State law and in excess of the storage capabilities of the water supply segment of Colebrook Reservoir. In order for these waters to be available for fish and wildlife purposes, provision would need to be made for increased storage in Colebrook Reservoir.

If the State did allocate some of the flows between 50 c.f.s. and 150 c.f.s. for fishery purposes, and legal right to store and release additional flows without riparian stoppage were vested in the Connecticut State Board of Fisheries and Game, then the fishery pool could be used either to maintain a reservoir fishery, or on a limited basis and at the State's discretion, to maintain suitable conditions for anadromous fishes in critical periods in the lower river. This would mitigate a portion of the shad fishery losses.

There have been discussions between the various Federal and State agencies involved to explore other possible mitigation measures. The M.D.C. has advanced the proposition that their water supply holdover storage could be held in Colebrook Reservoir providing a 5,000 acre-foot pool which would be drawn upon for water supply only in emergency situations. Low flow releases required by law would not normally be drawn from this pool.

This pool would mitigate fishery losses to the stream fishery for trout to a considerable extent and would be a reasonable equivalent of a single purpose fishery pool in this regard. It would, however, not permit the use of the stored water in the management of the anadromous fisheries and would leave losses to these fisheries unmitigated.

If the State moves to acquire water rights for fishery purposes, then a 5,000 acre-foot pool for fishery purposes would be desirable. In the absence of any such action the operation of Colebrook by M.D.C. to provide a reasonably permanent fishery pool of 5,000 acre-feet would provide mitigation for a major part of the fishery losses.

We recommend, therefore, that--

1. Fishery losses be mitigated through establishment of a 5,000 acre-foot pool for fishery management purposes in Colebrook Reservoir using waters available (a) as emergency supplies in Hartford M.D.C. operations, or (b) from acquisition of downstream privately-owned riparian water rights by the State of Connecticut and construction of 5,000 acre-feet of additional storage capacity for fishery management purposes in Colebrook Reservoir and Farmington River.

2. That access to Colebrook Reservoir specifically for fishermen be provided from both Connecticut and Massachusetts shores, including parking for 350 cars and construction of two launching ramps.

Sincerely yours,

A handwritten signature in cursive script, appearing to read "John S. Gottschalk".

John S. Gottschalk
Regional Director



UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
59 TEMPLE PLACE
BOSTON, MASSACHUSETTS 02111

June 1, 1964

Division Engineer
New England Division
U. S. Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

Your letter of March 18, 1964 asked about the feasibility of establishing a sizeable new fishery on the Farmington River as a consequence of providing 1.6 billion gallons of new storage for fishery purposes in Colebrook Reservoir. Your query was in relation to figures in the Farmington River Watershed Association's news release of March 5.

This letter constitutes a report on sport-fishery development features of the Colebrook project and was prepared under authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-666 inclusive). It was prepared in cooperation with the Connecticut Board of Fisheries and Game and has its concurrence as indicated in its letter of May 19, 1964.

Since the Allied Connecticut Towns, Inc. have signified in their letter of April 10 to the Connecticut Board of Fisheries and Game that they will cooperate in achieving a regimen beneficial to aquatic life and recreation, we are basing our analysis on the discretionary use of flows from 50 c.f.s. to 150 c.f.s. to achieve this regimen. The Board has also received the assurance of the Collins Company in their letter of April 7 that it will pass any stored water through their dam, and the Metropolitan District Commission in its letter of April 2 stated that disposition of waste water would not be of concern to them. This analysis is also contingent on construction of the fishway past Rainbow Dam which is presently in the planning stage.

While the provision only of a Metropolitan District Commission holdover pool of 1.6 billion gallons or of a fishery pool of this size would, over the project life, result in a net annual loss to the sport fishery, the combination of these two pools presents a much more desirable situation. This combination would eliminate any loss of fishing opportunity and would, in addition, provide for development of an expanded sport-fishery for American shad with average annual benefits of 18,000 fisherman days worth \$54,000 as a net recreational benefit. With assurance of these

EXHIBIT 2-1

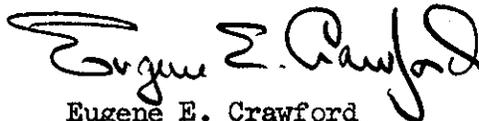
two pools, development of this expanded shad fishery could begin immediately so that this annual benefit would date from project completion.

If a regimen could be provided through the cooperative use of the various reservoir pools or through seasonal encroachment on the flood storage pool which would (1) allow the storage of early spring runoff from 50 c.f.s. to 150.c.f.s. and of any available waste water, (2) provide 1.6 billion gallons for the spring spawning and nursery period of American shad, and (3) still leave the M.D.C. holdover pool and the fishery pool full as we enter the summer, then there would be the potential for establishment also of a fall fishery for sea-run brown trout. Since development of this fishery could be concurrent with development of the shad fishery, an average annual benefit of 10,000 fisherman days would date from project completion and would have a net annual value of \$30,000.

We would therefore recommend--

1. That in addition to a holdover pool of 1.6 billion gallons, Colebrook Reservoir contain a fishery pool of 1.6 billion gallons.
2. That through cooperative use of available water and available storage capacity, an additional 1.6 billion gallons be made available for fishery use.

Sincerely yours,



Eugene E. Crawford
Acting Regional Director



UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
59 TEMPLE PLACE
BOSTON, MASSACHUSETTS 02111

August 27, 1964

Division Engineer
U. S. Army Engineer Division, New England
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

In answer to Mr. Hicks' request for additional information on the fishery aspects of Colebrook River Reservoir, we submit the following information and estimates as an aid to your planning procedures.

We have been advised that the Connecticut Board of Fisheries and Game has signed a contract for the design of a fishway at Rainbow Dam. They plan to request the January 1965 session of the legislature for construction funds for a fishway at Rainbow Dam, for a fishway at the Grist Mill Dam, and for removing an old dam at Spoonville. This will provide passage past Rainbow Dam for American shad and sea-run brown trout and will open up tributary spawning areas for the brown trout.

The program for establishment of sea-run browns in Connecticut streams was preceded by a successful pilot program in Latimer Brook in the Thames River Basin. With funds already requested for a fishway on the Salmon River and with a request for fishway funds for the Farmington River slated for January 1965, this is an active program with fishery benefits which should be realized in the near future.

On a long term basis, the maintenance of sizeable runs of shad and brown trout in the Farmington River above Rainbow Dam will depend on the availability to the State Board of Fisheries and Game of storage in the Colebrook River Reservoir which can be used at their discretion for downstream release. Attached is a copy of a letter to us from Commissioner Gill on plans to provide water rights for this purpose.

We have been asked to provide information on the fishery significance of providing a permanent pool of 5,000 acre feet from which releases could not be made for the downstream fishery. This would be in addition to an M.D.C. holdover pool of the same volume.

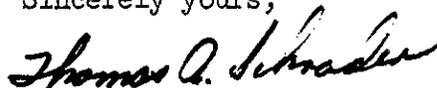
The holdover pool by itself while providing substantial mitigation will have certain limitations when cool bottom waters are diverted through the tunnel dropping warmer water from the upper reservoir layers into the holdover pool. The addition of a permanent pool will greatly increase the probability that suitable trout waters will exist throughout the summer allowing for an improved fishery and a carryover of fish from year to year.

During the first eight to ten years of the project the unallotted portion of the water supply pool will provide fishing opportunities. During the second ten years of the project before there are substantial diversions, there may not be a holdover pool. In this case the permanent pool would provide 35,000 fisherman days of use. During the last eighty years of project life a holdover pool and permanent pool combination would provide around 47,000 fisherman days annually of mitigation of which we would assign some 12,000 fisherman days to the addition of a permanent pool. The permanent nature of this pool and the greater likelihood of cool bottom waters is the basis for this value.

It should be understood that the above constitutes a planning aid letter based on informal discussions with the State and with access to only tentative information on reservoir design and operation with a permanent pool.

We would be happy to discuss the preparation of a formal Bureau report when more definite information is available.

Sincerely yours,



Thomas A. Schrader, Chief
Division of Technical Services

Enclosures



UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
59 TEMPLE PLACE
BOSTON, MASSACHUSETTS 02111

December 9, 1964

Division Engineer
U. S. Army Engineer Division, New England
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

Dear Sir:

We have reviewed your plan of operation for Colebrook River Reservoir transmitted with your letter of October 16. This letter is to confirm those benefit estimates given in our June 1, 1964 report and in our letter of August 27.

With the provision of a holdover pool, a temporary spring storage for flows to improve the American shad fishery, and of additional storage in the reservoir which will improve fishery conditions in the reservoir and in the river, as well as provide for the development of a sea-run brown trout fishery, there will be no fishery losses associated with the project, but instead substantial benefits.

We estimate that there will be an additional 28,000 man-days of fishing annually for American shad and sea-run brown trout with a net yearly recreational benefit of \$84,000.

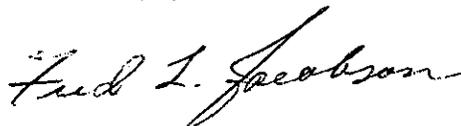
The fishery storage, or Pool c, will also improve fishing within Colebrook Reservoir, furnishing an additional 12,000 man-days of reservoir fishing annually with a yearly net recreational benefit of \$36,000. This benefit will be valid even in the event that Pool c could not be used for fall releases for the sea-run brown trout fishery.

We feel there should be an effort during detailed planning of Colebrook Reservoir operation to eliminate the short interim period in which the holdover pool would not exist and to insure that this pool would constitute the last 3% of the water supply to be drawn upon in emergency situations.

Pool b, for enhancement of the American shad fishery, would be more effective if these waters could be released as necessary from late April through June. We hope that subsequent more detailed analysis of operating factors will allow some later holdover in Pool b to allow June releases.

The Colebrook River Reservoir as presently planned will make a significant contribution to meeting the needs for sport fishing opportunity in this heavily populated area of Connecticut, and we appreciate the cooperation you have given us in working out the many details necessary to bring this about.

Sincerely yours,

A handwritten signature in cursive script that reads "Fred L. Jacobson". The signature is written in dark ink and is positioned above the typed name.

Fred L. Jacobson
Acting Regional Director



STATE OF CONNECTICUT

BOARD OF FISHERIES AND GAME

STATE OFFICE BUILDING • HARTFORD 15, CONNECTICUT

December 14, 1964

E.V. Ribbs
Colonel Corps of Engineers
U.S. Army Engineer Division, New England
Corps of Engineers
424 Trapelo Road
Waltham, Mass. 02154

Dear Colonel Ribbs:

Following are our comments on the Corps of Engineers' document entitled "Operation of the Colebrook River Reservoir", dated October 15, 1964, and your letter dated October 15, 1964.

This communications has been reviewed by Commissioner Gill of the Department of Agriculture and Natural Resources and by Director Wise of the Water Resources Commission and they concur with its contents. The plans of the Corps of Engineers has been discussed with Director Matthews of the Park and Forest Commission and he sees no objections to the proposals.

It should be noted at the outset that we in the Department of Agriculture and Natural Resources feel that the decision of the Chief of Engineers to change the plan of operation and add to the height of the Colebrook Reservoir Dam for the benefit of fisheries recreation is a major step towards the goal of optimum use of our natural resources, and this wise action should be commended by conservationists and recreationists throughout the country.

The following comments are made without benefit of the completed report of the Travelers Research Center (TRC). As you know, a comprehensive study of the Farmington River Basin is being made by TRC for the Department of Agriculture and Natural Resources in cooperation with the Farmington River Watershed Association. We do not anticipate that the final results of this study will materially affect our consideration of the Colebrook River Reservoir project, however, certain actions taken subsequent to the release of the final report may suggest changes in some phase of the development of this recreational resource. Any changes in our judgment, resulting from the above-mentioned report, will be submitted to you as they occur.

Essentially, we are in complete accord with the provisions related in your pamphlet entitled "Operation of the Colebrook River Reservoir". There are, however, certain areas which require comment, as follows:

1. Discontinuance of Pool a. We wonder if there is some analysis as to the number of years, or the percent of time when Pool a will be drawn upon for water supply or riparian purposes during the time the Metropolitan District

Commission (MDC) will require all of its water supply. Would not there need to be, somewhere in the water supply system (and why not in Colebrook), an emergency supply during this time period as well as during later times?

2. Definition of "emergency" storage. Since the actual "emergency" storage by the MDC may be as much as 25 percent of the total MDC capacity, it would be desirable to know where in this 25 percent storage the three percent in Colebrook (Pool a) fits into the emergency use picture. The value for fisheries purposes of this holdover storage would be somewhat reduced if it were between 75 and 78 percent rather than between 97 and 100 percent of the total MDC storage capacity.

3. Definition of "hurricane season". It is noted that water from flood encroachment stored in Pool b must be released in late April and May and subsequently it is stated that it will be released prior to the "hurricane season". Although the start of the release of this water would be in late April and May, the benefits derived would not be wholly realized unless a portion of this water remained for use during the entire shad migration which extends into June. In addition, in certain years when downstream flows may be adequate during April and May, additional benefits could be gained by delaying the release of the total amount of this water until the latest possible time. A more thorough description of the "hurricane season" with consideration for modern meteorological methods in hurricane detection and tracking, and safe drawn time of the flood encroachment pool would serve to more accurately define the period during which Pool b could be most beneficially used.

4. Operation of Pool b within unused future water supply storage capacity. During the time period prior to the total use of the water supply storage capacity by MDC it is conceivable that waters could be available to fill both the unused portion and Pool b within the flood zone. If this water (that stored in the unused water supply capacity) could be retained and used for in-reservoir recreation and/or alleviation of low downstream flows, additional benefits could accrue. If such circumstances occur to make this amount of water available, why need Pool b be operated within the unused water supply storage? This same proposition may be stated as the extension of Pool a into the unused water supply capacity as water is available. Certain additional recreational benefits could be gained from any available surplus water which could be stored in the unused water supply capacity regardless of how it were defined at the time.

5. Benefits accrued from Pool c. It is stated that Pool c is for the enhancement of the sea-run brown trout fishery. It should be pointed out that Pool c can, and in fact does, provide additional benefits of considerable value. As stated in the Sport Fishery Development Report from the Bureau of Sport Fisheries and Wildlife to the Division Engineer, New England Division, dated June 1, 1964, the sea-run trout (sea-trout) fishery is a potential. Nine years of study on this species by staff biologists has indicated the likelihood of high recreational benefits from the development of a run of these trophy fish. Of course, this development cannot occur instantaneously with the advent of improved stream conditions. The time required for the realization of total benefits from this species may extend to 10 years or more, dependent on many variables. However, during the intervening years and even after the need for Pool c water for sea-trout enhancement, this water will provide considerable additional benefits.

Until such time as the run of sea-trout is established, this water can be retained within the reservoir and will greatly increase the in-reservoir fisheries values. If it becomes desirable during this time, it would also be available for the alleviation of low downstream flows for the development of increased in-stream, put-and-take trout fisheries benefits which could, without this water and with anticipated water supply demands, be reduced nearly 75 percent. Also, with the advent of the sea-trout migration and the use of Pool c water as stated, it has additional values in that it also maintains river flows for the in-stream, put-and-take trout fishing, and again without this water these values may be reduced from present levels as much as 75 percent. Additionally this water has value for both in-reservoir recreation and low flow alleviation, since the two uses would not coincide in time; that is, the low flow alleviation would be after the most active in-reservoir recreation period.

Of additional concern to us, on the subject of Pool c, is the actual management of this water. We believe that the sole authority for the management of Pool c water should rest with this agency. Clarity on this subject would be appreciated.

6. Availability of water for filling fisheries storage, Pool b and Pool c. Analysis by Corps of Engineers' staff, TRC and our staff indicates that the 1.6 BG Pool c will fill from surplus water (defined below) 75 years of 100 under present conditions and 60 years of 100 in the year 2000 (assuming a 150 MGD draft rate, the tunnel to the East Branch complete and with no remaining riparian agreement, but with the 50-150 cfs commitment still in effect). An additional 1.6 BG storage (Pool c plus Pool b) will fill from surplus water 50 years of 100 under present conditions and 40 years of 100 in the year 2000. The above estimates are based on the assumption that the entire MDC capacity is empty each year, a condition which is remote.

In regard to the definition of "surplus water", the riparian owners and MDC have agreed to the following: Annual flows in excess of total capacity are considered surplus by MDC. Instantaneous flows at Collinsville in excess of 1000 cfs are wasted by the Collins Company. Instantaneous flows at Rainbow in excess of 2500 cfs when Rainbow Reservoir is full are wasted by the Farmington River Power Co. The capture of any flow above 150 cfs at Colebrook will not affect the rights of the Allied Connecticut Towns.

Representatives of the Allied Connecticut Towns have indicated in a recent meeting with our agency, a willingness to negotiate toward an agreement permitting water between 50 and 150 cfs to be stored between January 1 and April 15 for the purposes described. It is well to note that the Allied Connecticut Towns, Inc. was originally formed to protect various interests in the Farmington River, primarily those concerning adequate flows for recreational usage. I feel confident that the aims and interests of this group are identical to those of the Board of Fisheries and Game. A formal agreement with this group is presently being drafted and will be negotiated in the near future.

Since the worst conditions predictable ought to be satisfied, I will discuss the availability of water for storage on the basis of requiring additional water, other than from surplus, 60 years of 100 - that condition possible by the year 2000. It is assumed that at that time there would no longer be a riparian agreement and that the Collins Company would no longer generate, but that the 50-150 commitment would exist and that the Farming River Power Co. would still generate (perhaps not a valid assumption). Under such conditions, water must be made available six years in ten from the 50-150 flows, and since the use of this water will still be a right of the Farmington River Power Company, negotiations will have to be entered into with this company for this water.

Officials of the Farmington River Power Company, in correspondence and at a recent meeting, have expressed willingness to negotiate on the matter of storage of water useful to them for power generation. An agreement has been discussed whereby spring flows, stored and released during later low flow times, would tend to benefit the power company, therefore requiring no compensation. Waters in storage which are not returned on an annual basis or which are required for fishway operation or alleviation of low flows below Rainbow will be compensated for as described below.

During the time preceding the acquisition of the riparian rights by MDC, water will not be available from surplus for perhaps four years in ten. When this situation exists and 50-150 flows are used for fisheries storage, the Collins Company will have to be compensated since these flows are useful to them for power generation.

Since it is difficult to predict the amount of water which will be required for fisheries storage (Pool b and Pool c) from the 5-150 flows and to anticipate the time of need for this water, the compensation to the power companies for the use of the water might best be based on an average annual value of all riparian water. An agreement with each company is being drafted and will be negotiated in the near future. These agreements will provide for purchase of a maximum amount of riparian water for a maximum fee annually. Payment will be based on the volume of water taken during a given time period and computed by a formula which considers power values at the time, total riparian water value and relative value to each company. These agreements will be written for the life of the MDC riparian agreement with a provision for re-negotiation with the Farmington River Power Company when the riparian agreement with MDC is concluded. Section 26-3 of the General Statutes of Connecticut provides for the Board of Fisheries and Game entering into such negotiations.

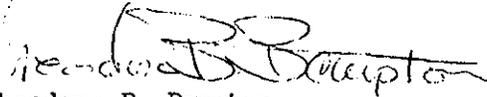
Note that the above arrangements are without benefit of legislative action. It is assumed that the legislative method of acquisition will be used only as a last resort if the above-described negotiations should fail, which seems highly unlikely in light of recent talks with the principals. The agreements described above, including that with the Allied Connecticut Towns, are being vigorously negotiated and copies will be transmitted to you as soon as they are complete.

December 14, 1964

7. Fish passage facilities at the Rainbow, Spoonville and Winchell-Smith Dams. As previously indicated, plans are presently being developed by a consultant engineer for these fish passage facilities. Preliminary plans and cost estimates are due from the engineer in the near future. In our biennial Capital Projects Budget recently submitted, this agency has requested funds to construct these facilities.

It is hoped that the foregoing will provide your office with further insight to the planning for this important recreational resource. If I can offer any additional information or aid to your staff, do not hesitate to contact me.

Sincerely yours,


Theodore B. Bampton
Director

TBB:RAJ:sg

cc: Commissioner Joseph N. Gill
Donald Mathews, Director
William Wise, Director



STATE OF CONNECTICUT
PARK AND FOREST COMMISSION
HARTFORD, 15, CONNECTICUT

DONALD C. MATHEWS
DIRECTOR

KEEP CONNECTICUT GREEN

December 4, 1964

File No. NEDED-D

Col. E. J. Ribbs
Acting Division Engineer
U. S. Army Engineer Division
424 Trapelo Road
Waltham, Massachusetts

Dear Colonel Ribbs:

Review of the Corps pamphlet entitled "Operation of Colebrook River Reservoir" including data and a diagram showing three fishing pools, indicates to us that the provision of increased storage for fisheries purposes in the Reservoir is an administrative and operative problem to be resolved by the State Board of Fisheries and Game.

This Commission would like, however, to have the following comments considered and incorporated into the final plans of the Reservoir project if you deem them feasible.

1. That the Corps in coordination with the State Highway Department investigate the possibility of the construction of an overlook turn-out and parking area with facilities adjacent to relocated Route 8. This proposed roadside area is sited approximately three thousand feet south of the Massachusetts state line, and located on the State Highway Preliminary Plan between Station 214+0 and Station 220+0.

2. That the Commission is aware of the drastic change in topography of the northwest quadrant of Eno Hill resulting from the proposal of the Corps to obtain "impervious" material from Borrow "C" as delineated on the Real Estate Map. The removal of the required yardage will disembowel Eno Hill and expose a borrow operation adjacent to what we anticipate to be the most scenic highway in the State.

Pending more informative data, we hope the Corps will consider our preliminary comments in this area. A solution to our second comment may be the incorporation, with the consent of the State Highway Department, of the construction of a well designed parking area including

Colonel E. J. Ribbs

- 2 -

December 4, 1964

facilities and screen plantings for the sole purpose of allowing the traveling public to ambulate or to hike a quarter of a mile north up to elevation 1061 feet and behold the grand view of the project Reservoir and its dam structures.

Sincerely yours,

A handwritten signature in cursive script, appearing to read "D.C. Mathews".

Donald C. Mathews
Director

dcm:apn

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
REGIONAL OFFICE
Region I
120 Boylston Street
Boston, Massachusetts 02116

PUBLIC HEALTH SERVICE

January 10, 1964

Mr. John William Leslie
Chief, Engineering Division
U.S. Army Engineer Division, New England
Corps of Engineers
424 Trapelo Road
Waltham 54, Massachusetts

Attention: Mr. Gardner Hicks

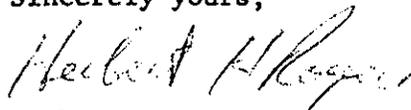
Dear Mr. Leslie:

The U.S. Public Health Service has completed investigations regarding the inclusion of storage in the Colebrook Project for streamflow regulation for water quality purposes. Our results indicate that there are no tangible benefits to be derived from the including of storage for streamflow regulation for quality control.

We do support the recommendation of reregulation at Collinsville and Rainbow Dams of the 50 cfs for fish and wildlife purposes, but these riparian negotiations are a State or local responsibility, and not within the realm of Federal participation.

We appreciate the opportunity to review this project, and if we can be of further service, please advise.

Sincerely yours,



Herbert H. Rogers
Regional Program Director
Water Supply and Pollution Control
Public Health Service

EXHIBIT 7

FEDERAL POWER COMMISSION

REGIONAL OFFICE

346 Broadway
New York, New York 10013

December 18, 1963

Division Engineer
U. S. Army Engineer Division, New England
424 Trapelo Road
Waltham 54, Massachusetts

Dear Sir:

Reference is made to your letter of November 22, 1963 and to recent discussions between representatives of our respective offices relating to the feasibility of hydroelectric power development at the proposed Colebrook Reservoir Project, Farmington River basin, Connecticut and Massachusetts.

It is understood that the dam site to be recommended in your current report is located on the West Branch of the Farmington River in Connecticut approximately $1\frac{1}{2}$ miles upstream of the existing Goodwin Dam. The latter, operated by the Hartford Metropolitan District, creates the West Branch Reservoir with a total storage capacity of 20,000 acre-feet for stream flow regulation.

The Colebrook dam would be constructed across the West Branch Reservoir at about its midpoint leaving 10,800 acre-feet of the West Branch capacity above Colebrook and 9,200 acre-feet between the two dams. The Colebrook Reservoir with a total storage capacity of 92,300 acre-feet at spillway crest elevation 756.0 would provide additional storage capacity of 30,700 acre-feet for water supply (elev. 641-700) and 50,800 acre-feet for flood control (elev. 700-756). Approximately 5,000 acre-feet of holdover storage would be maintained in the Colebrook pool for a reservoir fishery and would be drawn down only in extreme drought periods. Storage releases would be made through a 10-foot diameter-concrete conduit located on ledge and provided with control gates at its upstream end.

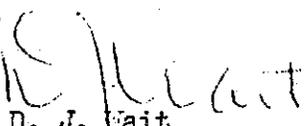
In order to develop dependable hydroelectric power at the Colebrook project, a minimum head would have to be maintained. This would require certain modifications in the proposed operation of both Colebrook and the West Branch Reservoirs. Under this plan the latter would be normally kept empty, thus providing about 9,000

acre-feet of storage capacity for flood control at times of extreme flood conditions. Flood control storage proposed for Colebrook would be reduced an equivalent amount leaving 41,800 acre-feet for this purpose (elev. 756-712) and 45,500 acre-feet of usable storage for joint use of water supply and power (elev. 712-621). With average tailwater at elevation 574 gross head available would vary from a maximum of 138 feet to a minimum of 47 feet, averaging about 95 feet. Minimum regulated flow would amount to about 150 cfs.

Installed capacity of the power plant would amount to 5,000 kilowatts capable of generating about 12,000,000 kilowatt-hours of average annual energy. Dependable capacity at minimum head would amount to about 3,000 kilowatts. The estimated first cost of the power installation, including lining of the concrete outlet tunnel, is \$1,300,000. With annual costs, based on Federal financing, estimated at \$85,000 and annual power benefits at \$125,000, the benefit-cost ratio is 1.46.

It is concluded, therefore, that the proposed Colebrook project as designed for flood control and water supply can be utilized for the economic development of hydroelectric power by coordinating its operation with the existing West Branch Reservoir. In order to provide for the installation of future power at the project, the proposed outlet tunnel should be designed initially for possible use as a power penstock. This would require a steel lining or sufficient reinforcement to withstand the increased pressures.

Sincerely yours,


D. J. Wait
Regional Engineer

FEDERAL POWER COMMISSION
REGIONAL OFFICE

346 BROADWAY
NEW YORK, NEW YORK 10013

August 17, 1964

Division Engineer
U. S. Army Engineer Division, New England
424 Trapelo Road
Waltham, Massachusetts 02154

Re: Colebrook Reservoir Project
Farmington River, Connecticut

Dear Sir:

Reference is made to your letter dated July 10, 1964 concerning the General Design Memorandum for the Colebrook Reservoir Project dated March 1964. It is understood that you propose to resubmit the Design Memorandum with revisions consisting of enlargement of the reservoir storage capacity for downstream fishery and inclusion of steel lining of the outlet tunnel to provide a penstock for future installation of power. Pursuant to your request we have reviewed your suggested revisions and the draft of Section "Y" of the report. Presented in the following are our comments thereon.

The proposed increase in height of dam would improve the amount of potential power but the additional costs involved could not be supported by power only. The proposed provisions for future power at Colebrook conform with the conclusions contained in our letter of December 18, 1963. The steel lining of the outlet tunnel when used as a power penstock should be designed to withstand a maximum dynamic pressure of 85 pounds per square inch, equivalent to 185 feet of head. Power operation as described in your Chapter "Y", 3rd paragraph, is satisfactory at times of major floods. The normal operating head would vary between 100 feet and 80 feet.

In answer to the request by the Chief of Engineers for additional information on the proposed future power plant, a tentative installation is described as follows:

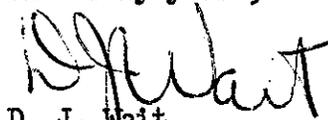
Division Engineer
U. S. Army Engineer Division, New England

August 17, 1964

A power plant with installed capacity of 5,000 kilowatts rated at 85 feet head, would be located immediately downstream from the tunnel outlet portal. The 10-foot diameter steel pipe would extend straight to a flood valve and would branch to the left with a pivot valve at the entrance of the turbine spiral casing. The equipment would be housed in a concrete structure 60 feet square. Reinforced walls would extend to above the maximum water level of the West Branch Reservoir and equipment access and assembly would be by derrick through a roof hatch. Location of the power plant is shown in the attached exhibit.

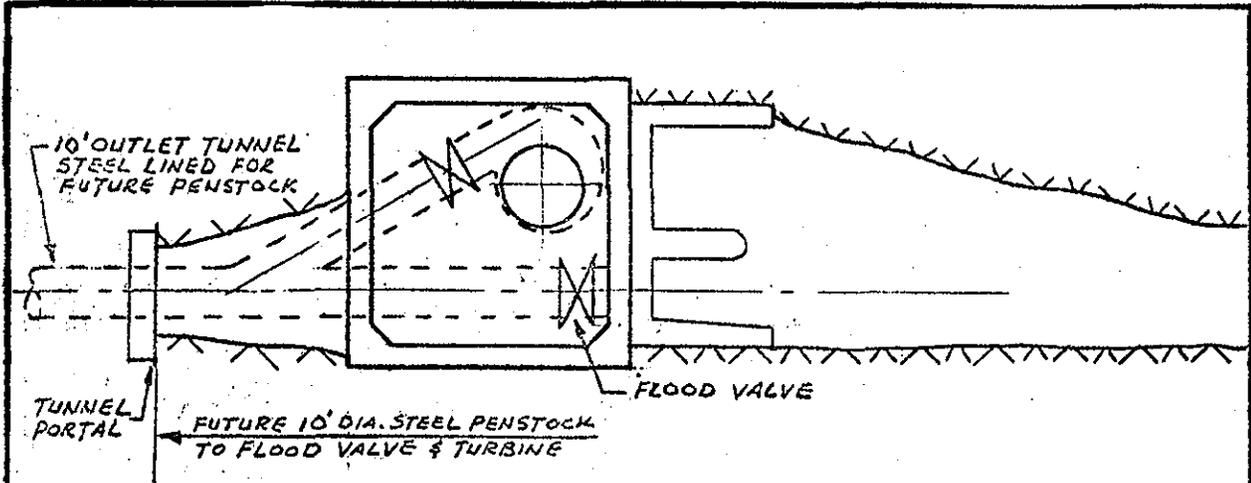
It is concluded that the suggested revisions in the General Design Memorandum involving the use of a steel lining in a portion of the reservoir outlet tunnel would provide a suitable penstock for the possible future installation of a power plant.

Sincerely yours,

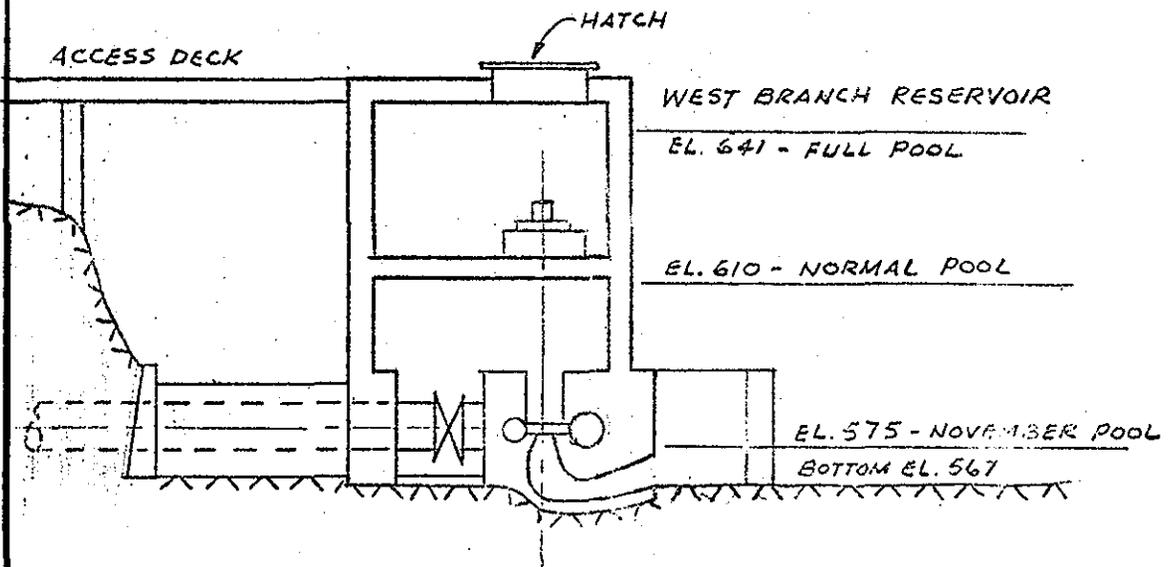


D. J. Wait
Regional Engineer

Enclosure:
Location Plan



PLAN



SECTION THRU POWER PLANT

FEDERAL POWER COMMISSION
 NEW YORK REGIONAL OFFICE
 LOCATION PLAN FOR FUTURE POWER INSTALLATION
 COLEBROOK RESERVOIR PROJECT
 FARMINGTON RIVER BASIN
 CONNECTICUT

SCALE: 1" = 40'

AUG. 1964



OFFICE OF THE DIRECTOR

The Commonwealth of Massachusetts

Water Resources Commission

73 Tremont Street, Boston 8

December 1, 1964

Brig. General Peter C. Hyzer
U. S. Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

Re: Colebrook Reservoir

Dear Sir:

On the request of Mr. Gardner Hicks of your staff, we are forwarding the following comments and recommendations regarding the proposed Colebrook Reservoir on the Farmington River, preliminary to formal action by the Water Resources Commission. The comments are as follows:

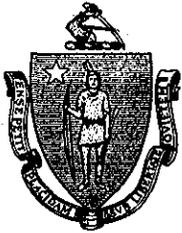
1. The Corps of Engineers acquire in fee to the limits of the proposed flood pool.
2. Additional acreage should be acquired if not by the Corps of Engineers, by the Commonwealth to place all land lying between Route 8 and the reservoir at flood stage. I understand that this becomes a problem with one farm located within this area. It is suggested in this case that you attempt to get an option to purchase this land so that the farmer may continue his operation.
3. Close liaison should be between the Corps and the Commonwealth during the acquisition phases in order to properly coordinate property surveys and land takings.
4. A Master Plan for recreational fish and wildlife usage should be completed prior to completion of plans so that construction work and road abandonments can be related to subsequent recreational activities.
5. Suitable storage and/or agreements should be included for compensating water to enable the Collins Company to hold a full reservoir at Otis reservoir from May 1 through October 1 of each year.

Your consideration of these comments will be greatly appreciated.

Very truly yours,
Malcolm E. Graf
Malcolm E. Graf
Director and Chief Engineer

MEG:im

EXHIBIT 10



The Commonwealth of Massachusetts
Water Resources Commission

~~15 School Street, Boston~~
15 SCHOOL STREET, BOSTON 02108

OFFICE OF THE DIRECTOR

January 20, 1965

Brig. Gen. Peter C. Hyzer
Division Engineer
New England Division
U. S. Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

RE: Colebrook Reservoir
Farmington River

Dear Sir:

At the Commission meeting on January 11, 1965, it was voted that the Water Resources Commission approve the proposed plan for the Colebrook Reservoir on the Farmington River.

The approval was based on comments from the Division of Fisheries and Game, the Department of Public Works, Division of Waterways, the Department of Public Works Highway Division, and the Department of Natural Resources. There were no objections from the Department of Public Works or the Division of Waterways to the proposed project, and there were no objections from the Highway Division regarding the relocation of Route 8.

The Division of Fisheries and Game felt that, although the proposed reservoir would inundate approximately 2 miles of trout streams during high water period, the fisheries benefits provided by the reservoir plan would, ^{result} in an increase to Massachusetts. They also expressed interest in regulating the drawdown of Otis Reservoir.

The Department of Natural Resources feels that it is necessary to obtain close liaison between the Corps and the Commonwealth during the acquisition phases in order to properly coordinate property surveys and land acquisitions. Thus, any lands desirable to have in the public domain that cannot be acquired by the Corps of Engineers can be most expeditiously obtained by the Commonwealth.

EXHIBIT II - I

It will also be necessary to prepare a Master Plan for recreational fish and wildlife uses prior to completion of plans so that construction work and road abandonments can be related to subsequent recreational activities. Suitable storage and/or agreements must be included for compensating water in the Colebrook Reservoir to enable the Collins Company to have a full pond at Otis Reservoir from June 1 through October 1.

Your consideration of these comments will be greatly appreciated.

Very truly yours,



Malcolm E. Graf
Director and Chief Engineer

MEG/n

THE METROPOLITAN DISTRICT

115 BROAD STREET
HARTFORD, CONN. 06105
TELEPHONE 525-0841

THE WATER BUREAU

8/GUG/BO

November 3, 1964

Colebrook River Reservoir

152-H-12

Division Engineer
U.S. Army Engineer Division, New England
424 Trapelo Road
Waltham 54, Mass.

Dear Sir:

We have received your letter of October 16, 1964, with copies of a report entitled "Operation of Colebrook River Reservoir" and dated October 15, 1964, with a request for comments in regard to the reservoir operation and the provision of necessary water rights as outlined in the report.

In general the various items and provisions covered in the report appear satisfactory. However, we would like to clarify or emphasize, even to the point of reiteration, several points to avoid any possible misunderstanding.

1. The pertinent data section of the report indicates that part of the water supply storage (15,350 acre feet) will be taken for immediate use and the remainder will be for future use. We have stated in our discussions with Mr. Gardner Hicks that we wish to retain flexibility on this matter to the extent that a decision on the amount to be taken for immediate use be deferred until the construction of the project nears completion and that the balance be taken at times as indicated by our actual water supply demands.

2. The term "general recreation" is used in the report with reference to the Colebrook River Reservoir. We point out again that Special Act 444 passed by the 1949 Session of the Connecticut General Assembly permits boating, hunting and fishing upon the West Branch Reservoir and within the limits of land owned by the District and located within the watershed of this reservoir. These activities are subject to regulations determined from time to time by a commission of seven members constituted in accord with the provisions of the Special Act. These same provisions were embodied in Special Act 122 passed by the 1963 Session of the Connecticut General Assembly with reference to property of the District within the watershed of the Colebrook River Reservoir. We remind you also of the fact that the

EXHIBIT 12 - 1

Colebrook River Reservoir

November 3, 1964

General Statutes of the State of Connecticut prohibit bathing or swimming in any water supply distribution or storage reservoir.

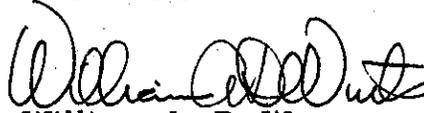
3. Relative to the availability of water, we discussed our position in a letter, dated April 2, 1964, to Mr. Lyle M. Thorpe, Director of the Connecticut State Board of Fisheries and Game, a copy of which was sent to your office, in which we stated:

a. In the period of time after completion of the Colebrook River Reservoir and before construction of the tunnel to the Barkhamsted Reservoir, inflows to the Colebrook River Reservoir in excess of 150 cubic feet per second would be considered waste or surplus water by the District only during the period when the District's water supply pools in the West Branch and Colebrook River Reservoirs are full, and the disposition of this waste or surplus water would be of no concern to the District.

b. After construction of the tunnel to the Barkhamsted Reservoir, inflows to the Colebrook River Reservoir in excess of 150 cubic feet per second would be considered waste or surplus water by the District only during the period when the Barkhamsted Reservoir and the District's water supply pools in the West Branch and Colebrook River Reservoirs are full, and again the disposition of this waste or surplus water would be of no concern to the District.

If there are any questions on any of these comments please do not hesitate to contact us.

Very truly yours,


Williams A. D. Wurts,
District Manager

Comm. McCormick
WADW, AJM
HAP, MJL, GUG

FARMINGTON RIVER WATERSHED ASSOCIATION, Inc.

24 EAST MAIN STREET, AVON, CONNECTICUT 06001

PHONE FARMINGTON 677-1241

Affiliated with THE CONNECTICUT RIVER WATERSHED COUNCIL

October 30, 1964

Col. E. J. Ribbs, Acting Div. Engineer
U.S. Army Engineer Division, New England
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

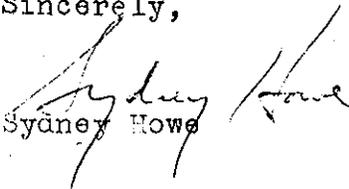
Dear Col. Ribbs:

Thank you for yours of October 16th enclosing the Corps report entitled "Operation of Colebrook Reservoir" and dated 15 October 1964. We are pleased with the general water utilization program outlined therein.

Your invitation to comment is appreciated. We have conferred with fisheries officials today on this subject and have agreed on certain modifications to be suggested to you.

Rather than submit a complete separate commentary, I think it would be simpler to await submission of the Connecticut Board of Fisheries and Game's comments. We expect to receive a copy and shall comment to you when we do, endorsing their suggestions and/or making supplementary comments.

Sincerely,


Sydney Howe

SH:jek

cc: Mr. Theodore Bampton

OFFICERS AND DIRECTORS:

RA P. KEARNEY - *New Hartford, President*
VAD N. MORRISON - *West Hartford, Vice-President*
MRS. JAMES J. FORD - *Farmington, Secretary*
RICHARD M. HEMINWAY - *Simsbury, Treasurer*
SYDNEY HOWE - *Executive Director*

E. BARTLETT BARNES - *Bristol*
RENE BURDET - *East Granby*
G. WINSTON CARTER - *Bristol*
JOHN E. ELLSWORTH - *Simsbury*
MRS. JOHN G. LEE - *Farmington*
N. PHILIP LORD, JR. - *Windsor*

BRUCE W. MANTERNACH - *Avon*
JOSEPH M. PUGLIESE - *Plainville*
MRS. CHARLES S. RUST - *Simsbury*
WILLIS A. SANFORD - *Winsted*
NORMAN F. THOMPSON, III - *Colebrook*

EXHIBIT 13

FARMINGTON RIVER WATERSHED ASSOCIATION, Inc.

24 EAST MAIN STREET, AVON, CONNECTICUT 06001

PHONE FARMINGTON 677-1241

Affiliated with THE CONNECTICUT RIVER WATERSHED COUNCIL

December 17, 1964

Col. E.V. Ribbs, Corps of Engineers
U.S. Army Engineer Division, New England
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Ribbs:

I believe we responded to yours of last October 16th by saying we would comment further after the Connecticut State Board of Fisheries and Game had submitted its own comments on the Corps report entitled "Operation of Colebrook River Reservoir."

We agree with the contents of Mr. Bampton's letter of December 14th to you on this subject, with the following qualifications and additions:

- Regarding Mr. Bampton's items 1) and 2), we can appreciate that present justification procedures and water supply policies make it seem desirable to describe accurately the nature and location of future "emergency storage". As a practical matter, however, we strongly suspect that by the time this becomes pertinent fishing will be allowed on the Barkhamsted and/or Mepaug Reservoirs. Under such conditions there will be recreation value in emergency storage at all three locations. We also suspect that recreation demands will lead to regulations under which considerable holdover storage is maintained in all three reservoirs, except under the rarest emergency situation.
- Concerning the future availability of water to fill Pool b. and Pool c. (Mr. Bampton's item 6.), we believe the assumptions made are unreasonably pessimistic. With the computer techniques available to the Corps it should be possible to estimate the frequency with which Pools b. and c. could be filled in the future on the basis of gradually increasing annual withdrawals by the Metropolitan District, as opposed to the present estimates which assume annual withdrawal of all DC water. We submit that the more plausible estimates would present a much more attractive picture.

However, we remain quite willing to pursue the water rights agreement between the Allied Connecticut Towns and the Connecticut Board of Fisheries and Game which Mr. Bampton discusses. We are in fact pursuing it right now.

OFFICERS AND DIRECTORS:

FRANKLIN P. KEARNEY - *New Hartford, President*
WALTER N. MORRISON - *West Hartford, Vice-President*
MRS. JAMES J. FORD - *Farmington, Secretary*
RICHARD M. HEMINWAY - *Simsbury, Treasurer*
SYDNEY HOWE - *Executive Director*

E. BARTLETT BARNES - *Bristol*
RENE BURDET - *East Granby*
G. WINSTON CARTER - *Bristol*
JOHN E. ELLSWORTH - *Simsbury*
MRS. JOHN G. LEE - *Farmington*
N. PHILIP LORD, JR. - *Windsor*

BRUCE W. MANTERNACK - *Avon*
JOSEPH M. PUGLIESE - *Plainville*
MRS. CHARLES S. RUST - *Simsbury*
WILLIS A. SANFORD - *Winsted*
NORMAN F. THOMPSON, III - *Colebrook*

EXHIBIT 14 - 1

We believe that the "perhaps four years in ten" absence of surplus water during a certain future period (middle of Mr. Bampton's page 4) is particularly misleading. But, again, there is no reason why agreements should not be concluded in the event that waters must be purchased from riparian owners. Nevertheless, four-in - ten might become something like one - in - ten under more feasible assumptions.

One general point which we feel should be emphasized is the breadth of benefits which the planned storages and flow-augmentation will bring in excess of fishing benefits. We can appreciate the difficulty of labelling these values. We do not mean to imply that your staff is unaware of them, but we think that the following should be listed as beneficial effects of the project:

Improvement in the quantity and possibly the quality of dependable flows from which direct withdrawals can be made for industrial, agricultural and, perhaps ultimately, domestic uses.

Improvement of non-fishing recreation opportunities on both the river and the Colebrook Reservoir, including aesthetic factors. A larger minimum pool in the reservoir will, although we must expect extensive bare mud areas at times, to some extent reduce the unpleasant aspect of same. The simple pleasures of walking near, picnicking beside, driving along, or in any way being exposed to the Farmington River will be enhanced by increased minimum flows.

Boating, particularly canoeing, may be possible only rarely under the Farmington's future water regimen. Perhaps, as the Corps has done elsewhere, brief flushes of water can be released from pool ~~b~~ by prior arrangement, for canoeing events.

Swimming areas on the river and in by-pass pools, particularly below Collinsville, may be usable and safe from a health point of view only with the augmentation of present minimum flows. The Town of Farmington, for example, contemplates a 2,000-person swimming area on a large pond being created in the river by gravel removal.

We appreciate your inviting us to comment on plans for the Colebrook project and hope that we have been of assistance.

Sincerely,

Sydney Howe

SH: jek
cc: Theodore B. Bampton
Dr. Paul Bock

EXHIBIT 14-2

THE TRAVELERS RESEARCH CENTER, INC.



November 12, 1964

Col. E. J. Ribbs
Acting Division Engineer
U.S. Army Engineer Division, New England
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Ribbs:

Thank you for sending us your pamphlet "Operation of Colebrook River Reservoir" and the attached letter of 16 October 1964 requesting our comments.

As you know, the Travelers Research Center has been undertaking an 18-month investigation, "Planning Study: Multiple Uses of Water Resources of the Farmington River Valley." This study is sponsored by the State of Connecticut and the Farmington River Watershed Association. Our final report is due January 18, 1965.

At this time we are not prepared to comment in any formal or detailed manner concerning your pamphlet. However, our computer studies of stream flow show good general agreement with the hydrologic aspects of your pamphlet, specifically those quantities found on page 6. As you know, we have been in contact for the past year or more with your Mr. Gardner Hicks, and other Corps engineers, concerning the overall hydrologic analyses.

We are indeed grateful for the fine cooperation afforded us by your engineers, and we expect to be in further contact with your staff as our study develops.

Sincerely yours,

Paul Bock, Director
Hydrology & Water Resources Division

PB:je

C O P Y

April 10, 1964

Mr. Lyle M. Thorpe
Director of Connecticut Board
of Fisheries and Game
State Office Building
Hartford 15, Connecticut

Dear Mr. Thorpe:

In response to your inquiry of March 25th concerning future availability of water discharged from the Hogback Dam, I can state the following:

1. As you estimate that the conditions in question will not prevail until perhaps 20 years hence, it might be difficult for the present directors of Allied Connecticut Towns, Inc. to take such action which would be binding so far into the future.
2. We can appreciate that minimum discharges from the Hogback Dam which the Metropolitan District is required to maintain under its agreement dated April 18, 1949 could, by means of special storage capacity built into the planned Colebrook River Dam for such purpose, be made to occur at times of the year in which said discharges would bring greater enhancement to the Farmington River downstream from the Hogback Dam than is caused under terms of the 1949 agreement.
3. We can also appreciate that such storage capacity in the Colebrook Reservoir regulated for public recreation purposes by the State of Connecticut will constitute a very desirably resource for the people of our region.
4. Due to the nature of this corporation, the reasons for which it was founded, and the purposes for which it will be continued, we have every reason to believe that the future officers and directors will accept the principles set down in the foregoing and will cooperate with the State of Connecticut in achieving a Farmington River flow regimen beneficial to aquatic life and recreation, insofar as our corporate powers are concerned.

Very truly yours,

S/ Hadleigh M. Howd
President, Allied Connecticut
Towns, Inc.

HHH/dfb

Exhibit 16

Sunday Courant
HARTFORD, Conn.
Circ. 168,428

JAN 3 1965

Allied Towns Committee To Work with Game Group

BARKHAMSTED (Special) — Atty. Hadleigh H. Howd, president of Allied Connecticut Towns, Inc., announced Saturday the appointment of a four-member committee to work with the State Fish and Game Department on control of water released from the Metropolitan District Water Bureau's Hogback Reservoir to benefit fish life downstream in the Farmington River.

The appointment came after a meeting here Tuesday where the Allied Towns approved the building of recreation areas and other projects in four area towns by MDC instead of MDC's rebuilding the Greenwoods Dam on the West Branch of the Farmington River at New Hartford.

Regulation Asked

The Tuesday conference was also attended by representatives of the State Fish and Game Department which is seeking permission to regulate waters from the Hogback Reservoir, to which Allied Towns has rights. The state wants to capture water in winter that Allied Towns has rights to and release it later in the year when it would be more advantageous to downstream recreation and future migration of sea run trout.

Howd announced Saturday night the Allied Towns Committee to negotiate with the state will include: Prosper F. Lavieri, of Barkhamsted; Mrs. Katharine S. Brown, of Colebrook; John B. Tamburini, of Bakersville, New Hartford; and Stanley A. Ransom of West Hartford.

Flowage Rights

Howd said the committee will "negotiate with the Fish and Game Department for more water release for the Farmington River."

He said "we have rights to minimum flow. We will probably give part of our rights over to the Fish and Game Commission." Atty. Howd said the state is "trying to work out a plan whereby there will be increased flow all year, which will make for better fishing."

Howd said Allied Towns will also have partial rights to water flow when the new Colebrook River Flood Control Dam is built on the West Branch of the Farmington River. The Corps of Army Engineers is planning the huge dam to be built within the basin of MDC's Hogback Reservoir. It will provide flood control for the Farmington River Valley and additional MDC water supply.

APPENDIX B

COST ALLOCATION

APPENDIX B
COST ALLOCATION

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APPENDIX B

COST ALLOCATION

COLEBROOK RIVER DAM AND RESERVOIR

FARMINGTON RIVER
CONNECTICUT RIVER BASIN
CONNECTICUT AND MASSACHUSETTS

1. General. - The Colebrook River Project is located on the West Branch of the Farmington River in the Town of Colebrook, Connecticut. The reservoir extends upstream into the Towns of Sandisfield and Tolland, Massachusetts. Plans and specifications were submitted to OCE on 17 November 1964 and approved on 23 December 1964. The project is being advertized for bids and bid opening is scheduled for 25 February 1965.

2. Plan of Improvement. -

a. Project Authorization. - The project was authorized by the Flood Control Act approved 14 July 1960, Public Law 86-645, House Document No. 443, Eighty-sixth Congress, Second Session, at an estimated cost of \$11,280,000 (exclusive of preauthorization studies). The project authorization provides for 50,800 acre-feet of flood control storage and 30,700 acre-feet of water supply storage, a total of 81,500 acre-feet.

The 5,000 acre-feet of storage for fish and wildlife improvement is included under the provisions of the Fish and Wildlife Coordination Act, approved 12 August 1958, Public Law 85-624, which reads in part as follows:

"(c) Federal agencies authorized to construct or operate water-control projects are hereby authorized to modify or add to the structures and operations of such projects, the construction of which has not been substantially completed on the date of enactment of the Fish and Wildlife Coordination Act, and to acquire lands in accordance with section 3 of this Act, in order to accommodate the means and measures for such conservation of wildlife resources as an integral part of such projects: Provided, that for projects authorized by a specific Act of Congress before the date of enactment of the Fish and Wildlife Coordination Act (1) such modification or land acquisition shall be compatible with the purposes for which the project was authorized; (2) the cost of such modifications or land acquisition, as means and measures to prevent loss of and damage to wildlife resources to the extent

justifiable, shall be an integral part of the cost of such projects; and (3) the cost of such modifications or land acquisition for the development or improvement of wildlife resources may be included to the extent justifiable, and an appropriate share of the cost of any project may be allocated for this purpose with a finding as to the part of such allocated cost, if any, to be reimbursed by non-Federal interests."

b. Related Improvements. - The Colebrook River project is a unit of the authorized plan for control of floods in the Connecticut River Basin. The completed Mad River Dam and the Sucker Brook Dam, now under design, are other smaller units in the Farmington River Basin.

The water supply is closely related to other units in the Metropolitan District System. Initially, it will be operated in conjunction with other projects to provide water for downstream power as a replacement for water being diverted into the domestic system. Later, when a diversion tunnel is completed from Goodwin Dam to Barkhamsted Reservoir and when present riparian rights are purchased, it will be used to provide water for domestic purposes.

c. Operational Requirements. -

(1) Flood Control - The flood control storage will be operated to control floods in the Farmington River Basin and in the lower reaches of the Connecticut River. Except for seasonal multiple purpose use as discussed below, the flood control storage will be emptied as soon as downstream conditions permit.

(2) Water Supply - On completion of the dam, the water supply storage for immediate use will be operated to provide water for hydroelectric generation at downstream industrial power plants. To the extent water is available, the immediate use storage will be filled on or before 15 May. Releases will be made principally between 15 May and 31 October. In general, it will be emptied early in the summer to permit possible reuse of capacity and maintenance of reserves in the Barkhamsted Reservoir for domestic use.

As the future water supply storage is taken for its authorized purposes, it will be operated in the same manner as above.

Immediately after completion of the diversion tunnel, this operation will continue. Soon thereafter, as domestic needs increase, the storage will be diverted into the domestic system. When substantial amounts of stored water are diverted, the Metropolitan

District will maintain 5,000 acre-feet of its reserves in the Colebrook River Reservoir as a holdover pool. This is fully discussed in the body of this General Design Memorandum and is referred to hereafter as Fisheries Pool a.

(3) Fisheries Pools - The Fish and Wildlife Service recommends three fishery pools. Each is of 5,000 acre-feet capacity. Sub-paragraphs (a), (b), and (c) discuss each of these briefly.

(a) Pool a is the holdover pool of the initial planning concept. It is essentially a permanent pool justified on the basis of mitigation of downstream fishery losses expected to occur as a result of future diversion of water into the Metropolitan District system. Provision of pool a does not increase the project cost.

(b) Pool b is for enhancement of the spring shad fishery. Water will be stored in the late winter and early spring and released in late April, May and June. This pool will be stored in the flood control storage zone after the spring snowmelt runoff and be released prior to the hurricane season. Provision of pool b requires additional reservoir clearing, but does not otherwise increase the project cost.

(c) Pool c is for enhancement of the sea-run brown trout fishery. Water will be stored in the winter and early spring and released in late summer. This storage required raising the dam by 5 feet. Provision of pool c increases the project cost by \$400,000.

(4) Water Rights - The situation as regards water rights in the Farmington River Basin is extremely complex. Under State law, riparian agreement and agreement with the Allied Connecticut Towns, a minimum release of 50 c.f.s. is required at the Goodwin Dam. In addition, the riparian agreement and agreement with the Allied Connecticut Towns require that the Metropolitan District pass all inflows up to 150 c.f.s. This was also a requirement of State law, but was repealed in 1963. Water for dependable operation of the fisheries pools will ultimately have to come from flows under 150 c.f.s. The Connecticut Fish and Game Commission is actively pursuing steps necessary to acquire the required water rights.

3. Authorization for Allocation of Costs. - Allocation of costs is required in order that all functions should share equitably in the joint savings of multiple purpose development. The Use of Facilities Method is used herein in accordance with the provisions of Paragraphs 1-85 and 1-86 of EM 1120-2-101 and the basis of project authorization shown in the Interim (Survey) report.

4. Description of Project. - The project is fully described in the body of this General Design Memorandum. Pertinent data are given in Table No. B-I, Pertinent Data. The project includes an earth and rockfill dam 1,300 feet long with a maximum height of about 223 feet, a dike approximately 1,240 feet long with a maximum height of 54 feet, a chute type spillway in the left abutment, outlet works and highway relocations. The spillway weir is 205 feet long and has a height of 14 feet. Total reservoir capacity, including existing storage and allowance for dead storage and sedimentation is 98,500 acre-feet. A steel liner is provided in the downstream 20 feet of the tunnel to permit a penstock connection for the future installation of 5,000 kilowatts of hydroelectric capacity. Between the centerline of the dam and the steel liner, the concrete tunnel lining thickness is increased and steel reinforcement added to allow for internal pressure.

Specific requirements are the parking areas and boat launching ramps provided for fishing and general recreation and the steel reinforcement and section of tunnel liner provided for future power. Since power is not a full project purpose and recreation is not an authorized project function for cost allocation purposes, these costs are not included in the allocation. Reservoir clearing is a specific requirement for fish and wildlife improvement and water supply, but not for flood control. All other project features are joint use features.

5. Construction Program. - The project is currently under design with plans and specifications having been submitted to OCE on 17 November 1964 and approved on 23 December 1964. Bids are scheduled to be taken in the spring of 1965 with construction starting early in the season. The project is expected to be operational for all purposes late in the Fall of 1968.

6. Project Costs and Charges. -

a. Construction Expenditures. - The total construction costs, including lands and relocations, are estimated at \$15,000,000 at 1964 price levels. No items will be furnished without cost. However, the acquisition of lands for the Metropolitan District's West Branch Reservoir, and clearing and removal of improvements has resulted in reducing land acquisition and clearing costs. The initial construction includes steel reinforcement in the portion of tunnel downstream of the centerline of dam and a 20-foot section of steel tunnel liner for possible future use for hydropower generation. Cost breakdown for the recommended multi-purpose project and for the alternative single and two purpose projects is shown in Table B-II, Summary of Construction Expenditures.

b. Operation and Maintenance. - Operation and maintenance is estimated on the basis of experience with other projects.

c. Interest during Construction. - Interest during construction is computed on the basis of a three-year construction period with interest at 3 percent for 1-1/2 years. While it will be 3 years and 4 months from the start of construction, about 1 May 1965, until the project becomes operational about 1 September 1968, the project will provide a considerable amount of flood control as soon as construction is initiated. This is because the West Branch Reservoir will be drawn down during the construction period and it will act as a retarding basin for flood control.

d. Annual Charges. - Annual charges for the single purpose flood control and multi-purpose projects are computed on the basis of the project life of 100 years with interest rate of 3 percent. Annual charges for the single purpose water supply project are computed on the basis of 100-year life with interest rate at 3.25 percent. Annual charges are shown in Table B-III.

7. Project Benefits. -

a. Flood Control Benefits. - Annual flood control benefits adjusted for the growth projected to take place in the basin over the life of the project amount to \$597,000.

b. Water Supply Benefits. - Water supply benefits are estimated on the basis of a single purpose water supply project constructed at the Colebrook River site. As the water supply would not be utilized for domestic purposes for 23 years after completion of the project, it is considered that the single purpose alternative project would be constructed 23 years later. A benefit-cost ratio of unity is assumed for this alternative project. Annual benefits for the multi-purpose project are discounted to reflect the present value of the alternative project. An interest rate of 3.25 percent was selected for computing water supply benefits on the basis of the most recent (November 1963) sale of District bonds.

In addition to water supply benefits, the Colebrook River project meets the need for downstream riparian flows on a temporary basis until the entire capacity is needed for the domestic system. Purchase of riparian rights, estimated to cost \$1,350,000 in 1968, would cost \$27,000 more on an annual basis than the same purchase made in 1992. The benefits resulting from the alternative single purpose project, \$175,000, are therefore increased by \$27,000 to \$202,000.

c. Fishery Benefits. - Annual fishery benefits from the downstream fishery improvement are \$54,000 and \$30,000 respectively for the shad and sea-run brown trout. Surplus water will be available for operation of the fishery pools for some years. Water for

dependable operation of the fishery pools will ultimately have to come from flows under 150 c.f.s. Acquisition of riparian rights for these flows will probably be required. Water rights will be purchased by the State of Connecticut. Purchase of each 5,000 acre-feet is expected to cost \$12,700 annually. This amount is discounted to a present worth value of \$10,000 since these water rights will not be required for about 10 years. This results in net values of \$44,000 for the shad fishery and \$20,000 for the sea-run brown trout. The addition of Pool c results in net annual benefits of \$36,000 for the reservoir fishery. Total net fishery benefits are \$100,000.

d. Recreational Benefits. - Recreation is not an authorized project function for cost allocation purposes. Reference is made to the body of this General Design Memorandum for recreational benefits.

e. Power Benefits. - Power is not a full project purpose. Costs and benefits are excluded from this allocation.

f. Summary of Benefits. - As shown below, and also in Table B-III, the project benefits are \$874,000. Only direct benefits were used for cost allocation in the separable costs-remaining benefits method.

SUMMARY OF BENEFITS

<u>Purpose</u>	<u>Direct Benefits</u>	<u>Incidental Benefits</u>
Flood Control	\$597,000	\$44,000(1)
Water Supply	202,000	
Fish and Wildlife	<u>56,000</u>	_____
TOTALS	\$855,000	\$44,000
TOTAL BENEFITS	\$899,000(2)	

(1) Incidental Fish and Wildlife Benefit from Pool b.

(2) Excluding Recreation and Future Power.

8. Alternative Projects. -

a. Alternative Two-Purpose Project for Flood Control and Water Supply. - For the purpose of comparison, the cost allocation for a two-purpose flood control and water supply project as originally authorized and without fish and wildlife as a project purpose was computed. Data is included in Tables B-I to B-III. The cost allocation is shown in Table B-IV.

b. Alternative Single Purpose Water Supply Project. - A single purpose water supply dam at the Colebrook River site was selected as the alternative project for computation of water supply benefits. However, this dam will not be needed for domestic purposes until 1992. Accordingly, its benefits were discounted to the value of its future cost in 1969. Data are included in Tables B-I to B-III.

In the event that the site were to be pre-empted by a flood control and recreation dam, then the Metropolitan District that owns the site, would claim in damages the amount by which its cost for a future single purpose project would be increased.

In addition to meeting the need for domestic water, the Colebrook River project permits delay in constructing a diversion tunnel from Goodwin Dam to Barkhamsted Reservoir. The cost, as published by the Metropolitan District, would be \$4,500,000. Also, the Colebrook River Reservoir would delay the need for acquisition of water rights. These same functions can be served by the purchase of power which would otherwise be generated by the water stored in the project. The value of this power is added to the benefits from the single purpose alternative.

Consideration was given to treatment of Connecticut River water. While this might be economically feasible, it was considered that aesthetic considerations would lead to selection of a relatively unpolluted source.

c. Alternative Single Purpose Flood Control Project. - A single purpose flood control dam at the project site is the alternative single purpose flood control project. The project is generally similar to the multi-purpose project. Data are included in Tables B-I to B-III.

9. Benefits - Cost Ratio. - The ratio of benefits to costs exclusive of area redevelopment, recreation and future power, is \$899,000 to \$530,150 or 1.7 to 1.

10. Cost Allocation by Use of Facilities Method. -

a. Legislative History. - In the Interim (Survey) Report, cost allocation was made by means of the Use of Facilities Method using specific costs rather than separable costs. This same method was used for the General Design Memorandum, approved on 4 June 1964.

b. Cost Allocation. - Table B-V shows the cost allocation prepared by means of the use of facilities method using specific costs.

11. Cost Allocation Analysis. -

a. This cost allocation meets the requirements of Paragraph 1-04 of EM 1160-2-101 that "The costs allocated to a particular purpose will not exceed the corresponding benefits and each purpose will be allocated at least its separable cost." The addition of fish and wildlife storage results in a reduction of water supply cost as a result of increasing the reservoir capacity thus reducing the unit cost per acre-foot. This is considered reasonable as all purposes should share in the benefits resulting from multiple purpose construction. Based on the allocation of joint costs only, the cost per acre-foot is the same for each purpose.

b. In commenting on the General Design Memorandum, OCE indicated that reservoir clearing cost should be a specific cost for water supply. The original cost allocation has been revised in line with this comment and is presented in Table B-IV and in the following summary for comparison with the allocation developed herein. The cost allocation shown in the Interim (Survey) Report is also included.

SUMMARY OF COST ALLOCATIONS

<u>Purpose</u>	<u>Interim (Survey) Report</u>	<u>Original Allocation Revised</u>	<u>Cost Allocation</u>
Flood Control	\$6,988,000	\$8,939,000	\$8,658,000
Water Supply	4,292,000	5,541,000	5,336,000
Fish and Wildlife	-	-	886,000
TOTAL	\$11,280,000	\$14,480,000*	\$14,880,000*

* Exclusive of costs for recreation and future power.

TABLE B-I

COLEBROOK RIVER PROJECT

Cost Allocation Studies
Pertinent Data

<u>Item</u>	<u>Unit</u>	<u>Three Purpose Project</u> <u>F.C., W.S., & F. & W.L.</u>	<u>Two Purpose Project</u> <u>F.C. & W.S.</u>	<u>Alternative Single Purpose Projects</u>	
				<u>Flood Control</u>	<u>Water Supply</u>
<u>GENERAL</u>					
Location		West Branch, Farmington River, 3.9 miles upstream from confluence with Still River	Same as Three Purpose	Same as Three Purpose	Same as Three Purpose
Drainage Area	Sq. Mi.	118	118	118	118
<u>RESERVOIR</u>					
<u>Elevation:</u>					
Top of Water Supply Pool	Ft., msl	701	700	641	700
Top of Fishery Pool	" "	708	-	-	-
Top of Flood Control Pool	" "	761	756	726	-
Stream Bed	" "	567	567	567	567
<u>Reservoir Area:</u>					
Top of Water Supply Pool	Acres	710	705	355	705
Top of Fishery Pool	"	750	-	-	-
Top of Flood Control Pool	"	1,210	1,150	875	-
<u>Storage Capacity:</u>					
Total	Ac-Ft.	98,500	92,500	61,800	41,700
Existing Water Supply	" "	11,000	11,000	11,000	11,000
Sediment & Dead	" "	1,000	-	-	-
Water Supply	" "	30,700	30,700	-	30,700
Fishery	" "	5,000	-	-	-
Flood Control	" "	50,800	50,800	50,800	-
<u>DAM AND APPURTENANCES</u>					
<u>Dam:</u>					
Type		Rolled earth and rock fill	Same	Same	Same
Elevation, top of dam	Ft., msl	790	785	755	729
Length	Ft.	1,300	1,285	1,145	1,025
Height	Ft.	223	218	188	162
Top Width	Ft.	30	30	30	30
<u>Dike:</u>					
Type		Rolled earth fill	Same	Same	Same
Elevation, top of dike	Ft., msl	790	785	755	None
Length	Ft.	1,240	1,100	90	-
Height	Ft.	54	49	19	-
Top Width	Ft.	30	30	30	-

TABLE B-I (Cont'd)

COLEBROOK RIVER PROJECT

Cost Allocation Studies
Pertinent Data

Item	Unit	Three Purpose Project	Two Purpose Project	Alternative Single Purpose Projects	
		F.C., W.S., & F. & L.	F.C. & W.S.	Flood Control	Water Supply
<u>DAM AND APPURTENANCES (Cont'd)</u>					
<u>Spillway:</u>					
Type		Uncontrolled Chute	Same	Same	Same
Elevation of Crest	Ft.msl	761.0	756.0	726	700
<u>Outlet Works:</u>					
Type		Tunnel in rock	Same	Same	Same
Size, diameter	Ft.	10	10	10	10
Gates, Service					
Number		3	3	3	3
Size	Ft.	4 x 8	4 x 8	4 x 8	4 x 8
Gates, Emergency					
Number		3	3	3	3
Size	Ft.	4 x 8	4 x 8	4 x 8	4 x 8

TABLE B-II

COLEBROOK RIVER PROJECT

Cost Allocation Studies

Summary of Construction Expenditures

	THREE-PURPOSE PROJECT				TOTAL COSTS	TWO-PURPOSE PROJECT	ALTERNATIVE SINGLE PURPOSE PROJECTS		
	Specific Costs			Joint Use Costs		Flood Control & Water Supply	Flood Control	Water Supply	Water Supply (Discounted) ⁽¹⁾
	Flood Control	Water Supply	Fish and Wildlife						
PERMANENT FEATURES									
Lands and Damages	\$	\$	\$	\$ 225,000	\$ 225,000	\$ 215,000	\$ 103,000	\$ 44,000	\$ 21,100
Relocations				5,780,000	5,780,000	5,780,000	4,582,000	3,352,000	1,606,300
Reservoir									
Log Boom				9,000	9,000	9,000	7,000	6,000	2,800
Clearing (See Table IV)		104,000	34,000		138,000	103,000		103,000	49,400
Dam				8,425,000	8,425,000	8,070,000	6,315,000	5,516,000	2,643,300
Road				153,000	153,000	153,000	153,000	153,000	73,300
Buildings, Grounds & Utilities				105,000	105,000	105,000	105,000	105,000	50,300
Permanent Operating Equipment				45,000	45,000	45,000	45,000	45,000	21,600
TOTAL PROJECT FIRST COST		\$104,000	\$34,000	\$14,742,000	\$14,880,000	\$14,480,000	\$11,310,000	\$9,324,000	\$4,468,100

INVESTMENT SUMMARY

Interest During Construction	\$ 4,700	\$ 1,500	\$ 663,400	\$ 669,600	\$ 651,600	\$ 509,000	\$ 454,500	\$ 217,800
TOTAL PROJECT INVESTMENT ⁽²⁾	\$108,700	\$35,500	\$15,405,400	\$15,549,600	\$15,131,600	\$11,819,000	\$9,778,500	\$4,685,900

(1) Alternative single purpose project required in 1992, discounted for 23 years to 1969.

(2) Exclusive of costs for recreation and future power.

TABLE B-III

COLEBROOK RIVER PROJECT

Cost Allocation Studies
Summary of Annual Charges and Benefits

	<u>THREE-PURPOSE PROJECT</u>				<u>TOTAL COSTS</u>	<u>PROJECT WITH FEATURE OMITTED</u>	<u>ALTERNATIVE SINGLE PURPOSE PROJECTS</u>		
	<u>Specific Costs</u>			<u>Joint Use Costs</u>		<u>Flood Control & Water Supply</u>	<u>Flood Control</u>	<u>Water Supply</u>	<u>Water Supply (Discounted)</u>
	<u>Flood Control</u>	<u>Water Supply</u>	<u>Fish and Wildlife</u>						
	<u>ANNUAL CHARGES</u>								
Initial Investment	\$108,700	\$35,500	\$15,405,400	\$15,549,600	\$15,131,600	\$11,819,000	\$9,778,500	\$4,685,900	
Interest on Initial Investment	3,260	1,070	462,160	466,490	453,950	354,570	317,800	152,300	
Amortization	180	60	25,420	25,660	24,970	19,500	13,500	6,500	
Operation and Maintenance	-	-	32,000	32,000	30,000	28,000	27,000	12,900	
Major Replacements	-	-	6,000	6,000	6,000	6,000	6,000	2,900	
TOTAL ANNUAL CHARGES	\$ 3,440	\$ 1,130	\$ 525,580	\$ 530,150	\$ 514,920	\$ 408,070	\$ 364,300	\$ 174,600	
	<u>ROUNDED TO: \$175,000</u>								
	<u>ANNUAL BENEFITS</u>								
Flood Control				\$ 597,000	\$ 597,000	\$ 597,000	\$ -	\$ -	
Water Supply									
Domestic				175,000	175,000	-	175,000	175,000	
Downstream Riparian Flow				27,000	27,000	-	-	-	
Fish and Wildlife									
Reservoir Fishery				36,000 ⁽³⁾	(1)	-	-	(1)	
Downstream Shad				44,000	44,000 ⁽²⁾	44,000	-	-	
Downstream Sea-Run Brown Trout				20,000	-	-	-	-	
Future Power					-	-	-	-	
TOTAL ANNUAL BENEFITS				\$ 899,000	\$ 843,000	\$ 641,000	\$ 175,000	\$ 175,000	

(1) Reservoir fishery provided for mitigation purposes.

(2) Benefit to shad fishery, incidental to flood control storage in alternative projects.

(3) In addition to mitigation.

TABLE NO. B-IV
ALLOCATION OF COSTS
FLOOD CONTROL AND WATER SUPPLY

Use of Facilities Method
(Using Specific Costs)

Proportionate Cost of Joint Facilities

<u>Item</u>	<u>Storage Acre-Feet</u>	<u>Percent</u>
Flood Control Storage	50,800	62.33
Water Supply Storage	30,700	37.67
TOTAL	86,500	100.0
 <u>Specific Costs</u>		
		<u>Amount</u>
		\$
Flood Control		0
Water Supply (reservoir clearing)		<u>138,000</u>
TOTAL SPECIFIC COSTS		\$ 138,000
 <u>Cost Allocation</u>		
Project Cost for multi-purpose reservoir		\$14,480,000*
Less specific costs		<u>-138,000</u>
TOTAL JOINT COSTS		\$14,342,000
Cost allocated to flood control		
Specific Costs		None
Joint Costs, \$14,342,000 x .6233		\$ <u>8,939,000</u>
TOTAL FLOOD CONTROL		\$ 8,939,000
Flood control, cost per acre-foot		\$ 176
Cost allocated to water supply		
Specific costs, clearing		\$ 138,000
Joint Costs, \$14,342,000 x .3767		<u>5,403,000</u>
TOTAL WATER SUPPLY		\$ 5,541,000
Water supply, cost per acre-foot		\$ 180

* Exclusive of costs of recreation and future power

TABLE NO. B-V

ALLOCATION OF COSTS

FLOOD CONTROL, WATER SUPPLY AND FISH AND WILDLIFE

Use of Facilities Method

(Using Specific Costs)

Proportionate Cost of Joint Facilities

<u>Item</u>	<u>Storage Acre-Feet</u>	<u>Percent</u>
Flood Control Storage	50,800	58.73
Fish and Wildlife	5,000	5.78
Water Supply Storage	<u>30,700</u>	<u>35.49</u>
TOTAL	86,500	100.0

Proportionate Cost of Reservoir Clearing

<u>Item</u>	<u>Amount</u>	<u>Percent</u>
Fish and Wildlife	10,000 ac.-ft.	24.57
Water Supply	<u>30,700 ac.-ft.</u>	<u>75.43</u>
TOTAL	40,700 ac.-ft.	100.0

Allocation of Reservoir Clearing Cost

	<u>Amount</u>
Fish and Wildlife (\$138,000 x 24.57%)	\$ 34,000
Water Supply (\$138,000 x 75.43%)	104,000

Specific Costs

Flood Control	0
Water Supply (reservoir clearing)	104,000
Fish and Wildlife (reservoir clearing)	<u>34,000</u>
TOTAL SPECIFIC COSTS	\$138,000

Cost Allocation

Project cost for multi-purpose reservoir	\$14,880,000*
Less specific costs	<u>- 138,000</u>
TOTAL JOINT COSTS	\$14,742,000

* Exclusive of \$57,000 and \$63,000 for recreation and future power respectively.

TABLE NO. B-V

(continued)

	<u>Amount</u>
Cost allocated to flood control	
Specific costs	None
Joint Costs, \$14,742,000 x .5873	<u>8,658,000</u>
TOTAL FLOOD CONTROL	\$8,658,000
Flood control, cost per acre-foot	\$170
Cost allocated to water supply	
Specific costs, clearing	\$ 104,000
Joint costs, \$14,742,000 x .3549	<u>5,232,000</u>
TOTAL WATER SUPPLY	\$5,336,000
Water supply, cost per acre-foot	\$174
Cost allocated to Fish and Wildlife	
Specific costs, clearing	\$ 34,000
Joint Costs, \$14,742,000 x .0578	<u>852,000</u>
TOTAL FISH AND WILDLIFE	\$ 886,000
Fish and Wildlife, cost per acre-foot	\$177
Cost allocated to future water supply, limited to 30% of total project cost \$15,000,000 x 0.30	\$4,500,000
Cost allocated to water supply for immediate use \$5,336,000 - \$4,500,000	\$ 836,000
Storage space allocated for water supply for immediate use $30,700 \times \$836,000 \div \$5,366,000$	4,800 ac.ft.
Percent of total storage allocated to water supply for immediate use $4,800 \div 86,500$	5.55
Percent of total storage allocated to water supply for future use $25,900 \div 86,500$	29.94
Percent of total storage allocated to flood control $50,800 \div 86,500$	58.73
Percent of total storage allocated to fish and wild- life improvement $5,000 \div 86,500$	5.78

TABLE NO. B-V

(continued)

SUMMARY OF COST ALLOCATIONS

Federal

Flood Control	\$8,658,000
Fish and Wildlife	<u>886,000</u>
TOTAL FEDERAL COSTS	\$9,644,000

Non-Federal

Water Supply for Immediate Use	\$ 836,000
Future Water Supply	<u>4,500,000</u>
TOTAL NON-FEDERAL COSTS	\$5,336,000*

* Non-Federal costs for water supply are to be paid initially by the Federal Government subject to reimbursement in accordance with the project authorization.