Periodic Inspection Report No. 5
Hancock Brook
Plymouth, Connecticut

Hancock Brook Lake

November 1995

US Army Corps
of Engineers

New England Division

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Plymouth, Connecticut

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This inspection has been conducted under the authority in ER 1110-2-100, which provides for the "Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures." The purpose of the inspection is to examine the physical condition of the Hancock Book Lake project as part of a continuing program to insure its structural stability, safety, and operational adequacy. The field examination includes soils and geologic aspects of embankments, channels, and other components, as well as structural, concrete, mechanical, electrical, and hydrologic and hydraulic features of the project.

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Periodic Inspection; dam safety.

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CENED-ED-EC

22 April 1996
Mr. Forbes/bd/78885

MEMORANDUM FOR Chief, Water Control Division

SUBJECT: Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures - Hancock Brook Lake, Plymouth, Connecticut

1. Reference CENED-ED-WH memorandum of 11 March 1996, SAB

2. The Periodic Inspection Report Technical Review Board met on 27 March 1996. Based upon this meeting, subject report is approved pending resolution of attached comments.

3. The Board complimented the fine staff effort in incorporating the major format changes required by ER 1110-2-100.

4. The next inspection of Hancock Brook Lake Dam will be scheduled for FY 2001.

RICHARD D. REARDON
Director of Engineering

Encl

CF (w/encl):
Mr. Reardon - 112S
Mr. Wong - 106N
Mr. Mackos - 116S
Mr. Singh - 117S
Mr. Forbes - 112S
Eng. Dir. Files - 112S

CENED-ED-WH

11 March 1996
Mr. Acone/mbc/78162

MEMORANDUM FOR Director of Engineering

SUBJECT: Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures--Hancock Brook Lake, Connecticut

1. Enclosed is the fifth Periodic Inspection and Evaluation Report for Hancock Brook Lake. This inspection was performed in November 1995. As required by the new version of ER 1110-2-100, dated 15 February 1995, the report has been submitted to the PI Review Board for approval. This PI report, prepared under the new format, is forwarded as a draft copy. All comments made by the Board will be incorporated into the final document.

2. With the exception of items listed in section 6, "Recommendations," remedial measures discussed in the report will be implemented through normal maintenance procedures.

3. Based on the age and condition of the project, we recommend the next inspection be conducted in FY01.

4. Additional copies of this report are available in Water Control Division, and can be obtained by contacting Scott Acone on X78162.

Encl

H. FARRELL MC MILLAN
Chief, Water Control Division

CF:
Mr. Acone - 115N ✓
Mr. Forbes - 112S (w/encl)
Mr. Mackos - 116S (w/encl)
Mr. Singh - 117S (w/encl)
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PERIODIC INSPECTION REPORT NO. 5
HANCOCK BROOK LAKE
PLYMOUTH, CONNECTICUT

NOVEMBER 1995

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS 02254-9149

PERIODIC INSPECTION REPORT NO. 5
HANCOCK BROOK LAKE
PLYMOUTH, CONNECTICUT

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PERIODIC INSPECTION REPORT NO. 5
HANCOCK BROOK LAKE
PLYMOUTH, CONNECTICUT

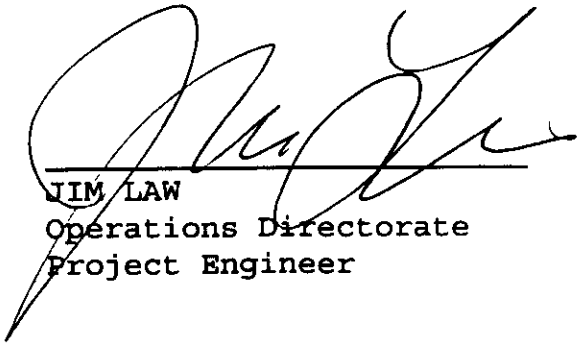
1. EXECUTIVE SUMMARY

a. The fifth periodic inspection of Hancock Brook Lake was performed on 7 November 1995. The inspection was conducted by a team of specialists representing various disciplines from Design, Geotechnical Engineering and Water Control Divisions of the Engineering Directorate, and Operations Directorate, New England Division, Corps of Engineers.

b. The purpose of the periodic inspection was to examine the physical condition of the Hancock Brook Lake project as part of a continuing program to insure the structural stability, safety and operating adequacy. The field examination included soils and geologic aspects of embankments, channels and other components, as well as the structural, concrete, mechanical, and hydrologic/hydraulic features of the project. The scope of work did not include an evaluation of the project design and construction for compliance with present design criteria.

c. Based on visual inspection, project features of Hancock Brook Lake are generally in good condition. No deficiencies which could jeopardize the operation of the project during flood events were identified.

for DAVID MARGOLIS
Water Control Division
Hydraulic Engineer
(Team Captain)



JIM LAW
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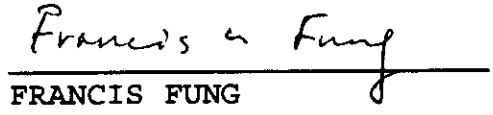

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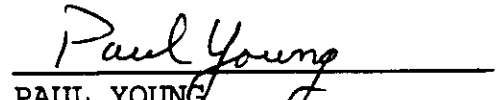


PAUL YOUNG
Geotechnical Eng Division
Geologist

2. GENERAL STATEMENT OF INSPECTION PROGRAM

a. Authority for periodic inspections is contained in ER 1110-2-100 which provides for the "Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures." This program requires a detailed, systematic, technical inspection of each Corps-owned facility whose failure or partial failure would endanger the lives of the public or result in substantial property damage.

b. Failure at Hancock Brook Lake has the potential to result loss of life and cause serious damage to homes, extensive agricultural, industrial and commercial facilities, important public utilities, main highways, or railroads. Based on the hazard potential criteria adopted by the U.S. Army Corps of Engineers and presented in Appendix D of ER 1110-2-106 "Recommended Guidelines for Safety Inspection of Dams," Hancock Brook Lake is a high hazard dam.

c. Approval authority for periodic inspection reports has been delegated by HQUSACE to the Division Commander, U.S. Army Corps of Engineers, New England Division, who has deferred to Director of Engineering. This approval process includes an in depth review by Engineering and Operations Directorates.

3. PROJECT DESCRIPTION

a. Hancock Brook Lake is a flood control reservoir situated on Hancock Brook in the town of Plymouth, Connecticut, about 3.4 miles above its confluence with the Naugatuck River (figures 1 and 2). With a drainage area of 12 square miles, it is operated to reduce flooding on the main stem of Hancock Brook.

b. The dam at Hancock Brook Lake is rolled earth fill with rock slope protection with an uncontrolled, ogee weir and chute in rock spillway across the main channel of Hancock Brook. In addition, the project has three dikes associated with it. Normal discharges are passed by an ungated rectangular concrete conduit located in the

spillway. Maximum outlet capacity at spillway crest is 377 cfs and the full flood control pool occupies 266 acres and provides 4,030 acre-feet of storage.

4. BRIEF PROJECT SUMMARY

a. Construction Conditions. Construction of Hancock Brook Lake was begun in July 1963 and completed in August 1966. Total cost of construction was $4,178,911.

b. Project Characteristics

Purpose	Flood control
Location of Structures	
State	Connecticut
County	Litchfield
Town	Plymouth
Reservoir	
Drainage Area	12.0 square miles

Operating Levels

Pool	Elevation (NGVD)	Area (acres)	Cumulative Capacity (acre-ft)
Invert	454.0	---	---
Conservation Pool	460.0	40	130
Flood Control (Spillway Crest)	484.0	266	4,030

Dam	
Type	Rolled earth fill, rock slope protection, impervious core
Maximum Height	57 feet
Length	630 feet
Top Elevation	505.0 feet NGVD

Spillway

Location	right-west abutment
Type	Uncontrolled with chute in rock, ogee weir
Crest Length	100 feet
Crest Elevation	484.0 feet NGVD
Maximum Discharge Capacity	16,600 cfs

Intake

Intake	Concrete weir with stoplogs
Gates	2'X 2' manual sluice gate (used only to drain pool)
Invert	454 feet NGVD

Outlet Works

Type	Rectangular concrete conduit
Size	3' x 4.5'
Length	250 feet
Gates	Ungated
Discharge at Spillway Crest	377 cfs
Stilling Basin	Bedrock channel

Dikes

Type	3 earthfill, rock slope protection
Length	2,500 feet total
Top Elevation	505.0 feet NGVD

c. Significant Storages Since Last Inspection. Table 1 lists significant storages recorded at Hancock Brook Lake since the last inspection.

TABLE 1

SIGNIFICANT STORAGES AT HANCOCK BROOK LAKE
SINCE LAST INSPECTION

	Maximum	Storage Utilized		
Date	Elevation	Inches	Acre-Feet	Percent
Mar 1992	465.2	0.5	350	9
Jun 1992	470.1	1.5	945	24
Mar 1993	465.2	0.5	350	9
Aug 1994	465.8	0.6	405	10

One inch of runoff = 640 acre-feet
Drainage Area = 12 square miles
Zero Stage = 454.0 feet NGVD

d. History of Major Remedial Measures. There have been no major remedial measures performed at this project.

e. Deficiencies Corrected Since Last Inspection

(1) This periodic inspection of Hancock Brook Lake was the fifth conducted since initiation of the dam inspection program. Listed below are the dates of prior inspections:

Periodic Inspection No. 1	Mar 1972
Periodic Inspection No. 2	May 1981
Periodic Inspection No. 3	Oct 1985
Periodic Inspection No. 4	Oct 1990

(2) Results of intermediate inspections or site visits since the last periodic inspection are included in Appendix VI, Intermediate Trip Reports, however, there have been none.

(3) Deficiencies at the project which have been corrected as a result of findings presented in the last periodic inspection are listed below.

(a) Performed minor patch work on concrete in 60" RCP from diversion dikes number 1 and 2 in FY94 at a cost of $6,000.

(b) Replaced exposed electrical conduit with a solar battery unit in FY91 at a cost of $500.

(c) Installed six piezometers to measure porewater pressure in the embankment in FY95 at a cost of $50,000.

(d) Vegetation on the dam and dike was sprayed in FY93. PI No. 4 recommended spraying every four years. Spraying should be repeated in FY97.

f. Past Deficiencies Not Yet Corrected. Deficiencies which have been identified in the past but not yet corrected are listed below.

(1) Reset flap gate in correct position for diversion dike no. 1, manhole no. 1, and seal the joint between the steel flap gate frame and the end of the pipe. Repair additional cracks and deteriorated concrete in 60-inch RCP for diversion dikes no. 1 and 2. Operations directorate to budget within next two years. Estimated cost is $65,000.

(2) Perform mapping of the fractures in the rock around the left spillway wall and monitor the progressive movement. This item was not funded. Geotechnical team members reevaluated and changed this recommendation. Project personnel should visit the site yearly to observe current conditions of the rock. The project manager should contact GED in the event movement of the rock is observed.

(3) Remove row of stones in outlet channel. After further inspection, the stones do not appear to obstruct flow, and the cost of removal is not justifiable.

5. INSPECTION RESULTS

a. This inspection was performed by the following personnel from Engineering and Operations Directorate.

David Margolis	Hydrology/Hydraulics (Team Captain)	CENED-ED-WH
Francis Fung	Concrete/Structural	CENED-ED-DG
Paul Young	Geology	CENED-ED-GG
Laura Fraser	Geotechnical	CENED-ED-GD
Jim Law	Operations	CENED-OD-P
Kenneth Paton	Mechanical	CENED-ED-DG

Other personnel at the inspection were as follows:

Thomas Rosato	Operations	CENED-OD-P
Leslie Butler	Stamford Barrier Project Manager	CENED-OD-P
Christopher Way	Hop Brook Lake Park Ranger	CENED-OD-P
Brian Toenges	Hop Brook Lake Park Ranger	CENED-OD-P
Reese Morgan	Naugatuck River Basin Manager	CENED-OD-P

b. Embankment

(1) Main Dam. Visual inspection of the dam embankment and abutment areas showed no indication of settlement, lateral movement, sloughing of slopes, significant irregularities or evidence of instability that would affect its performance. There is no apparent vertical or horizontal misalignment.

(a) Crest. The gravel on the crest of the dam is in good condition. There is no apparent sign of sloughing or cracking along the crest. Alignment of the crest is good.

(b) Upstream Slope. The slope is in good condition and appears stable with no indication of movement or sloughing. Stone quality is good but the size varies

with an occasional weathered piece of schist disintegrating to fine material. There are several small trees and brush beginning to take root at the toe of slope.

(c) Downstream Slope. The downstream slope appears stable. The stone protection material on the surface is highly variable in size. There are numerous scattered schist blocks on the surface that have weathered to fines. There is no significant erosion of these fines at this time.

(d) Seepage. No piping, boils or sink holes were observed during the inspection or reported by the Project Manager. A small amount of standing water (1-2 inches) was noted in the crushed stone fill between the diversion drainage ditch and the downstream toe of the slope. Historically, there has been water accumulated in this area as it is surrounded by higher ground (Photo E-3). The drainage ditch constructed to drain this area appears to have too flat a gradient or it may slope towards the dam.

(e) Drainage Ditch. The edges of the drainage ditch are overgrown with light brush making access along its length difficult. Light flow of water is visible where the crushed stone fill meets the drainage ditch. However, there is stagnant water at several sections along the ditch. As noted above, the drainage ditch appears to have too flat a gradient to afford complete drainage for the crushed stone fill. Where the drainage ditch meets the outlet channel there is an accumulation of settled material causing the water flow in this area to decrease further, and, during times of high tailwater a reverse flow along the ditch may exist. In addition, a parcel of land southeast of the ditch has been leased to the town, and a soccer field has been constructed. On the day of inspection there were hay bales and a silt fence in place between the soccer field and the drainage ditch. Potential impacts of the soccer field on the drainage ditch appear minimal.

(f) Intake Service Road. The gravel-surface road from the dam crest to the inlet along the upstream slope is in good condition.

(2) Dikes. There are three dikes associated with Hancock Brook Lake. A main dike runs parallel and west of the Penn Central railroad tracks. It crosses Waterbury Road about 2,000 feet from the dam along the east bank of the reservoir. In addition, two small diversion dikes are located on private property upland of the railroad tracks. Two 60-inch diameter reinforced concrete pipes (RCP) run from the diversion dikes under the main dike and into the reservoir (figure 3). The Corps' legal responsibility is limited to maintenance of the main dike. In September 1991, a determination was made by Real Estate Directorate that the Corps was not legally responsible for maintenance of either the diversion dikes or conduits, which are owned by Penn Central Transportation Corporation. However, NED has adopted the policy of maintaining the two 60-inch diameter RCPs from the point where they cross under the main dike onto Corps' property. As a result, the two diversion dikes were not inspected, while portions of the 60-inch RCPs, which lie under the main dike, were inspected.

(a) Main Dike. The main dike showed no indication of misalignment, settlement, or other evidence of instability that would affect its performance. Indications of abnormal seepage or sloughing of stone slopes were not observed during the inspection or reported by the Project Manager. The upstream stone slopes and gravel crest roadway are in good condition. Grass cover on the downstream slope is dense and well maintained. Vegetation on the upstream stone slopes is minor.

(b) 60-inch RCP from Diversion Dike No. 1. Deficiencies still exist from last inspection. They are scheduled for repair within the next two years. They include: the steel frame supporting the flap gate at the discharge end of the pipe was originally set about 6 inches above the invert; there is a 1 1/2-inch transverse crack just inside the steel flap gate frame; water is leaking from construction joints along the conduit.

(c) 60-inch RCP from Diversion Dike No.2. Deficiencies still exist from last inspection. They are scheduled for repair within the next two years. They

include: deterioration of the concrete around the steel flap gate frame; exposed steel rebar; leakage from the flap gate.

c. Spillway.

(1) Approach. The overall condition of the approach channel is good with no major obstructions. There are a few small pine trees near the junction of the channel and reservoir.

(2) Weir. The overall condition of the concrete in the spillway weir is good. There are minor spalls along the upstream and downstream edges of the weir, but they will not affect hydraulic capacity of the channel. The transverse crack that was reported in the last report has slightly increased, but will not affect the integrity of the spillway weir (see photo A-9).

(3) Retaining Walls. The overall condition of the spillway retaining walls appears to be good and shows no significant change from the previous inspection. There are large cracks in the left rock wall just past the weir (as noted in previous inspections). One small block of rock (approximately 2 ft by 2 ft) has slipped off the face since the last periodic inspection. Most bonding and alignment of joints show no sign of unusual movement. The chain link fence on top of the wall is in good condition.

(4) Exit. The spillway exit channel is in good condition with no major outgrowth of trees or vegetation which would obstruct flow. Approximately 100 feet downstream of the weir, the ground is wet and there is a small amount of flow in the downstream direction. Flow appears to be coming off of the right rock wall and through the ground. Some water is backed up at the confluence with the downstream river.

d. Outlet Works

(1) Approach

(a) Inlet Channel. The inlet channel is in good condition with no major obstructions. The partially submerged log boom appears to be in good working condition. Some small trees and brush have grown up around the safety fences (photo D-4). The inlet channel bottom was not inspected.

(b) Intake Structure. The spall on the top inside edge of the headwall was patched but there are various small spalls along the top edge of the headwalls. A concrete spall is located at the corner near the protective beams of the gate operator (photo A-10). The tubular steel supports for the lower platform, which also serve as trash racks, are rustier than they were last inspection (photo A-11).

(c) Manually Operated Weir Sluice Gate. The manually operated sluice gate in the weir at the intake structure is normally left in the closed position, and is only used to dewater the pool. The gate was below the water during the inspection which permitted only a poor visual inspection. No deficiencies were noted. The gate was operated through a complete open/close cycle. The manual operator performed satisfactorily.

(d) Conduit. The 3- by 4.5-foot outlet conduit was not observed during the initial inspection due to the depth and velocity of the water in the channel. A video inspection performed on 29 October 1986 was monitored by NED personnel and was the last inspection of this conduit. Physical inspection of the conduit should be performed this summer when the water level and temperature are acceptable.

(e) Outlet Structure. The overall condition of the concrete in the outlet structure is good. The condition of three vertical cracks and one horizontal crack in the west wall has not worsened since the previous inspection. The amount of the efflorescence along the horizontal construction joint above the conduit and along the vertical crack extending the full height and width of the east wall has increased moderately since the last inspection (photos A-12 and A-13). All weepholes are functioning properly, and

the chain link fences on top of the outlet walls have only minor rust. The conduit has not been inspected due to high water level.

(f) Exit Channel. The exit channel was in good condition. There are several small stones across the channel about 40-feet downstream from the outlet, as noted in the previous inspection. These stones will have very minor impact to the channel flow capacity.

e. Project Instrumentation

(1) Rain Gage. The project is no longer equipped with a rain gage due to vandalism problems associated with unmanned projects and coverage provided by nearby gaged projects.

(2) Pool Stage Recorder. The pool stage recorder, which consists of a Sutron 8200A Data Collection Unit in the concrete bubble gage shelter, is in good condition. At the time of inspection, the pool level was at 7.4 feet (Elevation 461.4 feet NGVD).

(3) Bubble Gage Shelter. The overall condition of the concrete and structure is good. The hairline cracks in the northwest corner of the west face of the roof slab and the cold joint that extends around the entire perimeter of the roof slab have remained unchanged since the last inspection. The shelter stairs have settled approximately 1/2 inch, as indicated in the last inspection report (photo A-14). The bottom edge of the metal door has rusted and it should be repainted (photo A-15).

(4) Staff Gage Bases. The overall condition of the concrete in the staff gage bases is good.

(5) Embankment Instrumentation. Instrumentation to monitor embankment performance consists of crest monuments, control points, and piezometers. The crest monuments are all in working condition. Monument 3 was run over by a bull dozer but appears to be in working order. Control point,

Mon A, had been damaged prior to the 1995 survey, but was relocated during the survey. A complete discussion of the geotechnical instrumentation, interpretation, and evaluation of data are contained in Appendix VII of this report, Instrumentation Data and/or Plots.

6. RECOMMENDATIONS

The inspection team members and project personnel held an exit meeting at the dam where the findings and recommendations were jointly discussed. Needs and actions were of the "normal maintenance" category, except as follows:

a. Perform inspection of the outlet conduit and weir sluice gate when water level and temperature are acceptable. This inspection can be done by a structural engineer from Engineering Directorate before the end of the year.

b. Reset flap gate in correct position for diversion dike no. 1, manhole no. 1, and seal the joint between the steel flap gate frame and the end of the pipe. Repair cracks and deteriorated concrete in 60-inch RCP for diversion dikes no. 1 and 2. Operations directorate to budget within next two years. Estimated construction cost is $55,000; estimated E&D costs is $10,000.

c. Schedule the next periodic inspection for FY01.

APPENDIX I

HISTORY OF REMEDIAL MEASURES

PERIODIC INSPECTION REPORT NO. 5
HANCOCK BROOK LAKE
PLYMOUTH, CONNECTICUT

HISTORY OF REMEDIAL MEASURES

There have been no major remedial measures at this project.

APPENDIX II

PHOTOGRAPHS

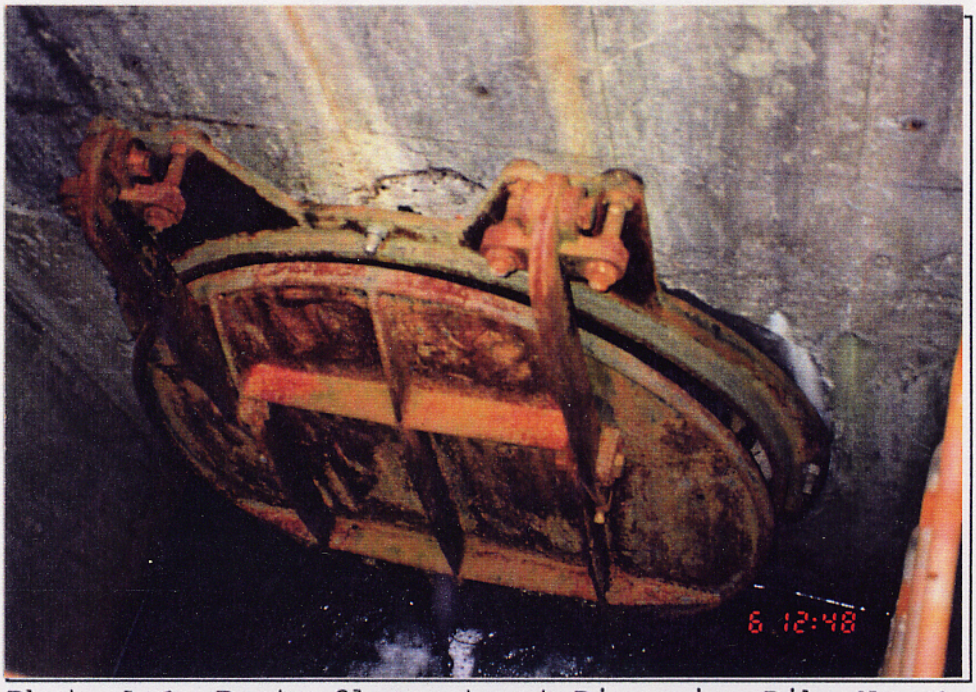


Photo A-1. Rusty flap gate at Diversion Dike No. 1.

Photo A-2. 1-1/2" wide circumferential cracks at the steel flap gate frame in Diversion Dike No. 1.

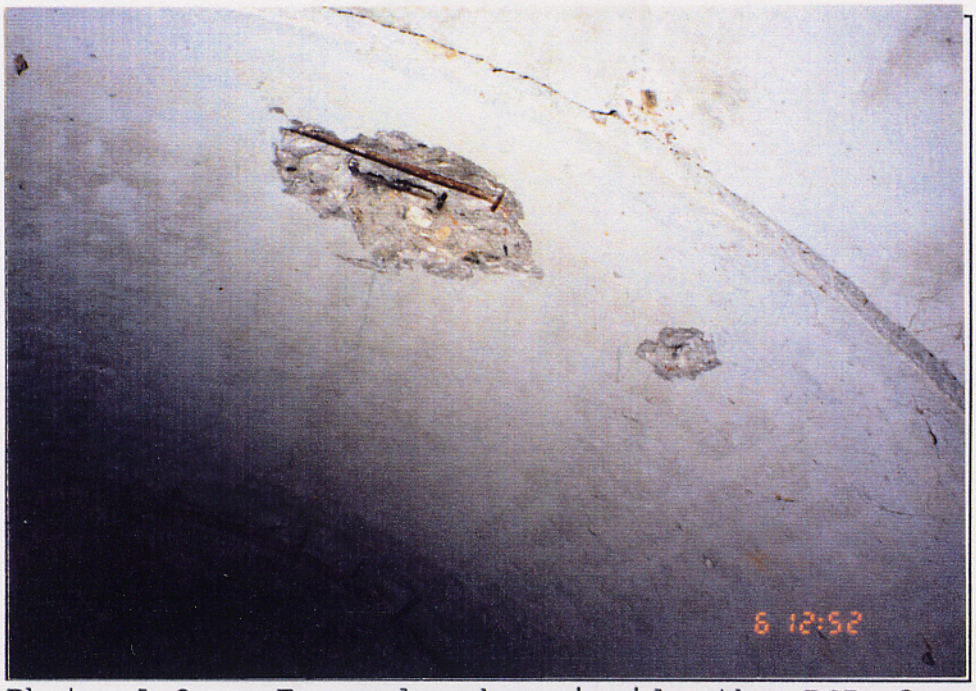


Photo A-3. Exposed rebar inside the RCP from Diversion Dike No. 1.

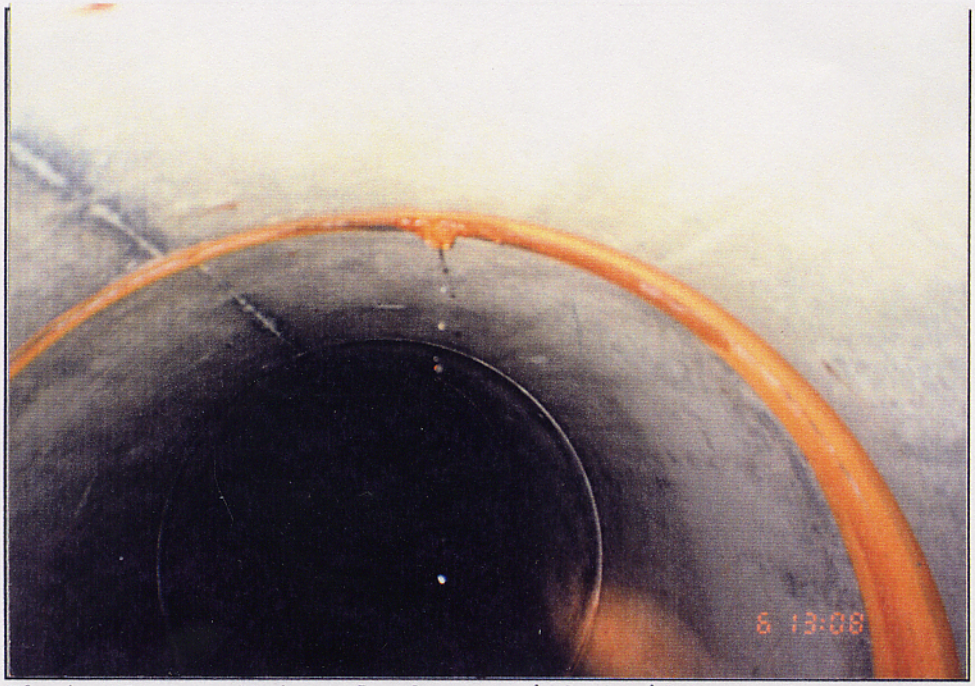


Photo A-4. Water leakage with buildup of orange, rust colored material inside Diversion Dike No. 1 RCP.

Photo A-5. Concrete spall and exposed rebar around the external end of the RCP pipe opening in Diversion Dike No. 1.

Photo A-6. Rusty steel flap gate for the 60" RCP in Diversion Dike No. 2

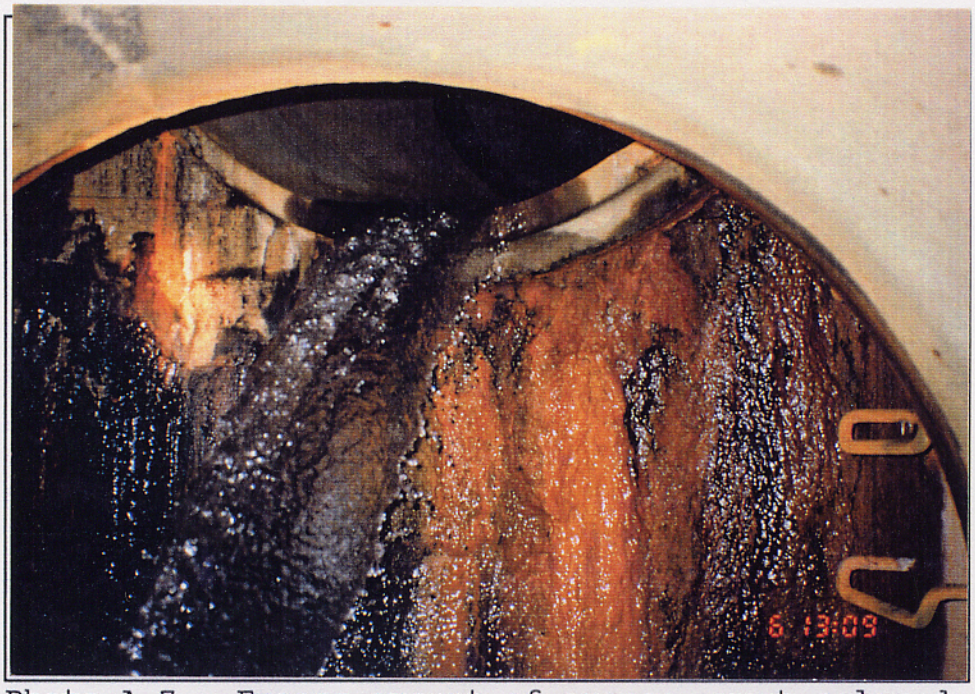


Photo A-7. Excess amount of orange, rust colored material buildup at the flap gate of Diversion Dike No. 2.

Photo A-8. Exposed rebar and concrete spall at the top of pipe in Diversion Dike No. 2.

Photo A-9. Minor spalls at the spillway weir.

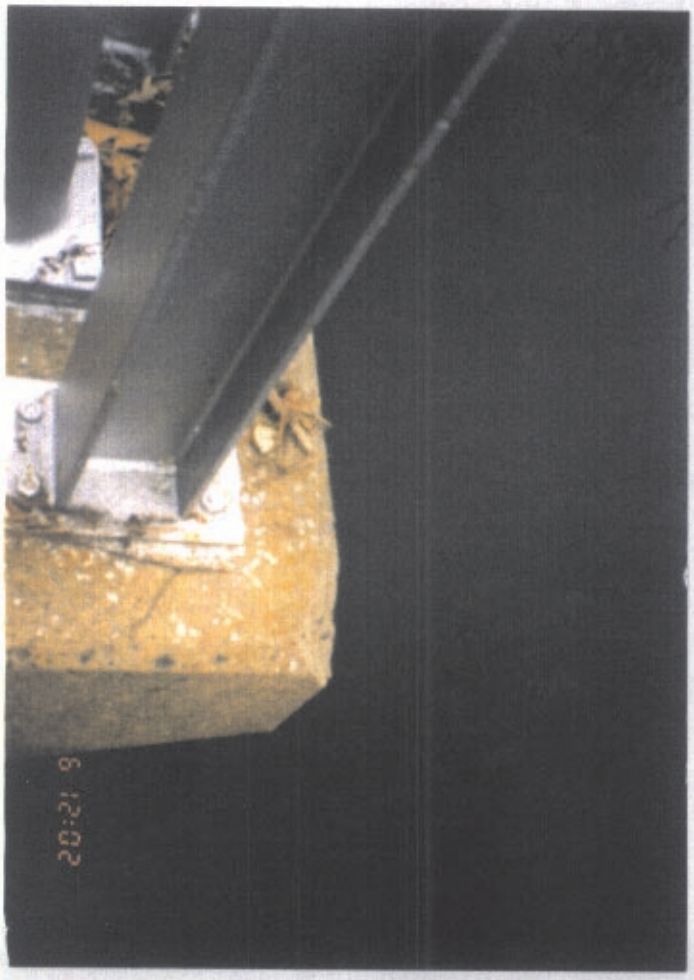


Photo A-10. Concrete spall at the corner near the gate operator protective beams

Photo A-11. Rusty trash rack at the inlet structure.

Photo A-12. Efflorescence along the horizontal construction joint above

Photo A-13. Vertical crack along the east wall of the outlet structure.

Photo A-14. Settlement of stairs to the bubble

Photo A-15. Rusty bottom edge of metal door of bubble gage shelter.

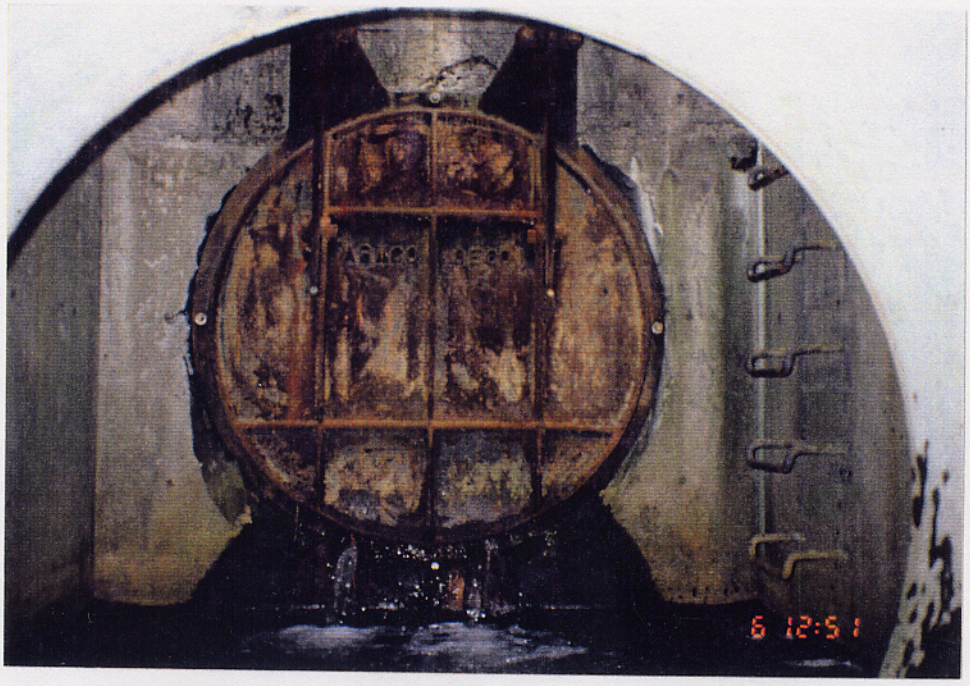


Photo B-1: Diversion Dike 1 Flap Valve

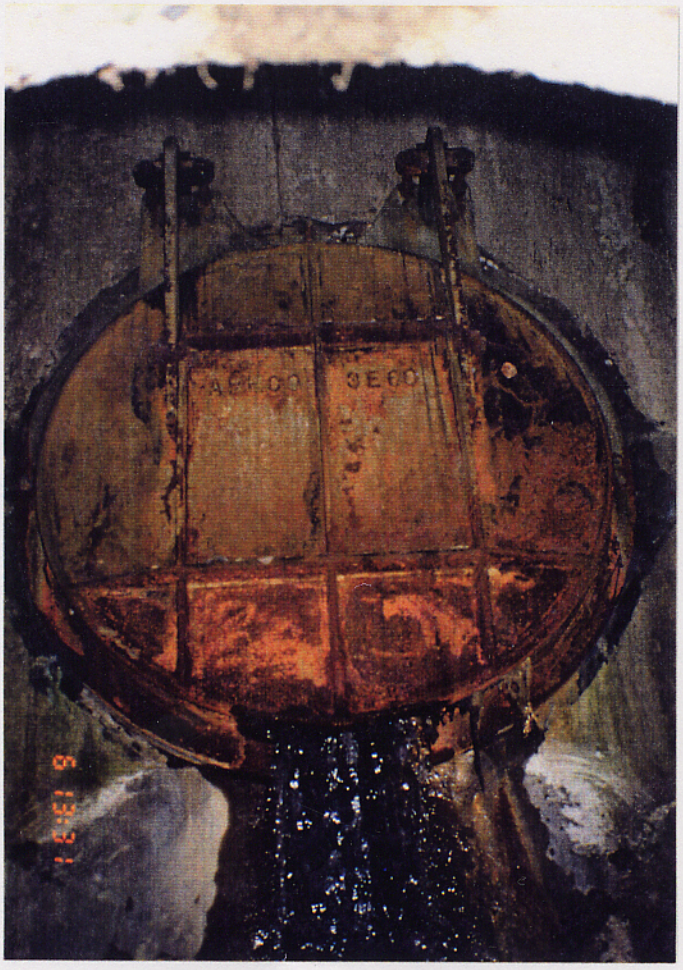


Photo B-2: Diversion Dike 2 Flap Valve

Photo D-1. Spillway approach channel.

Photo D-2. Spillway weir.

Photo D-3. Spillway exit channel.

Photo D-4. Inlet channel and log boom.

Photo D-5. East side of intake weir.

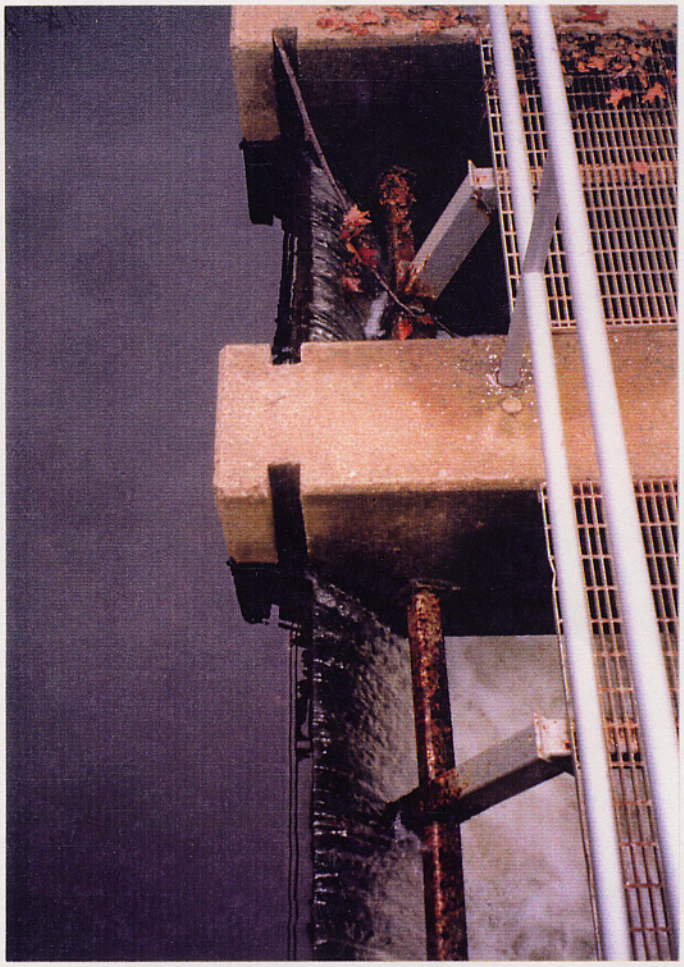


Photo D-6. West side of intake weir.

Photo D-7. Looking downstream at exit channel.

▲PHOTO E-1: Upstream slope and toe access road.

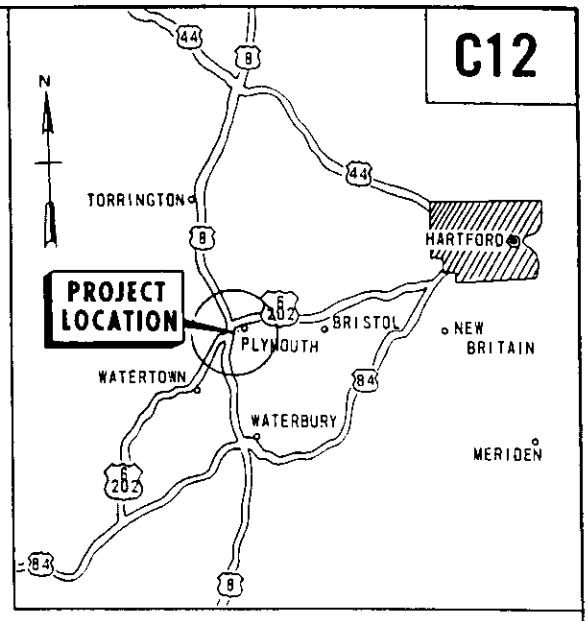
▲PHOTO E-2: Downstream slope and toe.

▲PHOTO E-3: Downstream toe - crushed stone fill area.

▲PHOTO E-4: Spillway Channel left rock wall

▲PHOTO E-5: Intake structure. Note brush grown up around the safety fence.

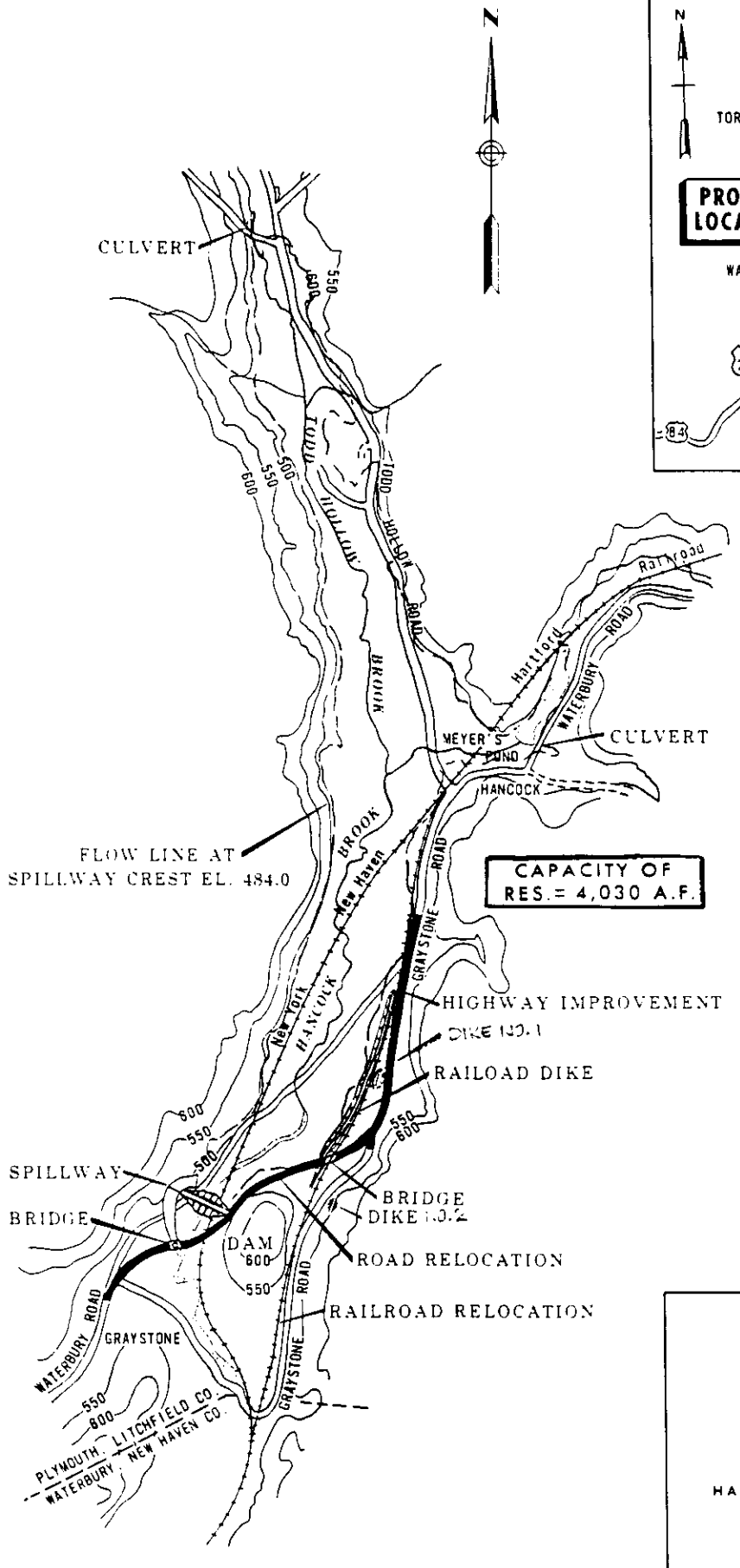
▲PHOTO E-6: Outlet channel. Stone pile across channel is under water on right side of photo.



VICINITY MAP

SCALE IN MILES

5 0 5 10 15



HOUSATONIC RIVER BASIN

HANCOCK BROOK LAKE

RESERVOIR MAP

30 SEPTEMBER 1984

HANCOCK BROOK CONNECTICUT

SCALE IN FEET

500 0 500 1000

NEW ENGLAND DIVISION WALTHAM, MASS.

FIGURE 1

CORPS OF ENGINEERS U.S. ARMY

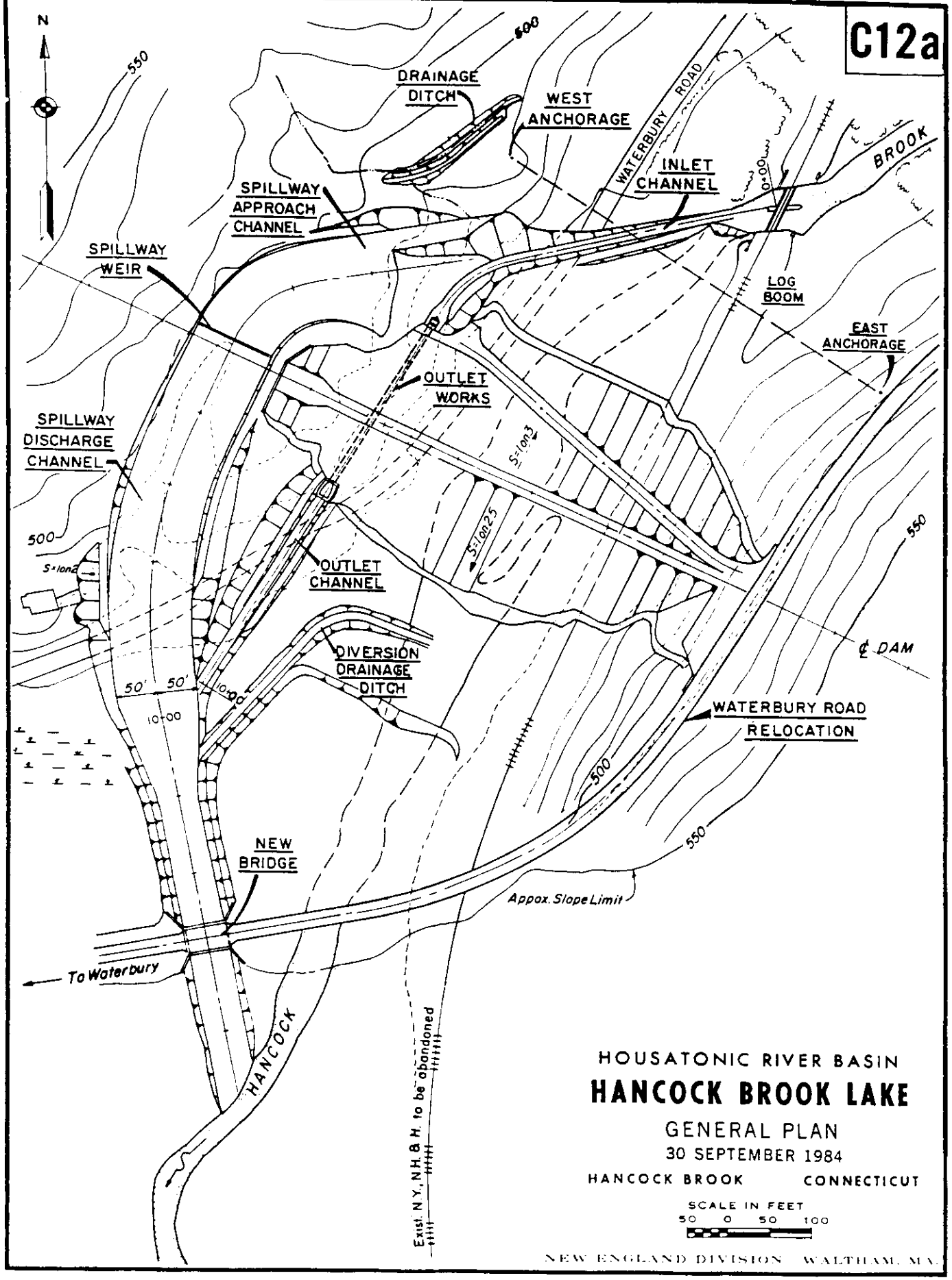
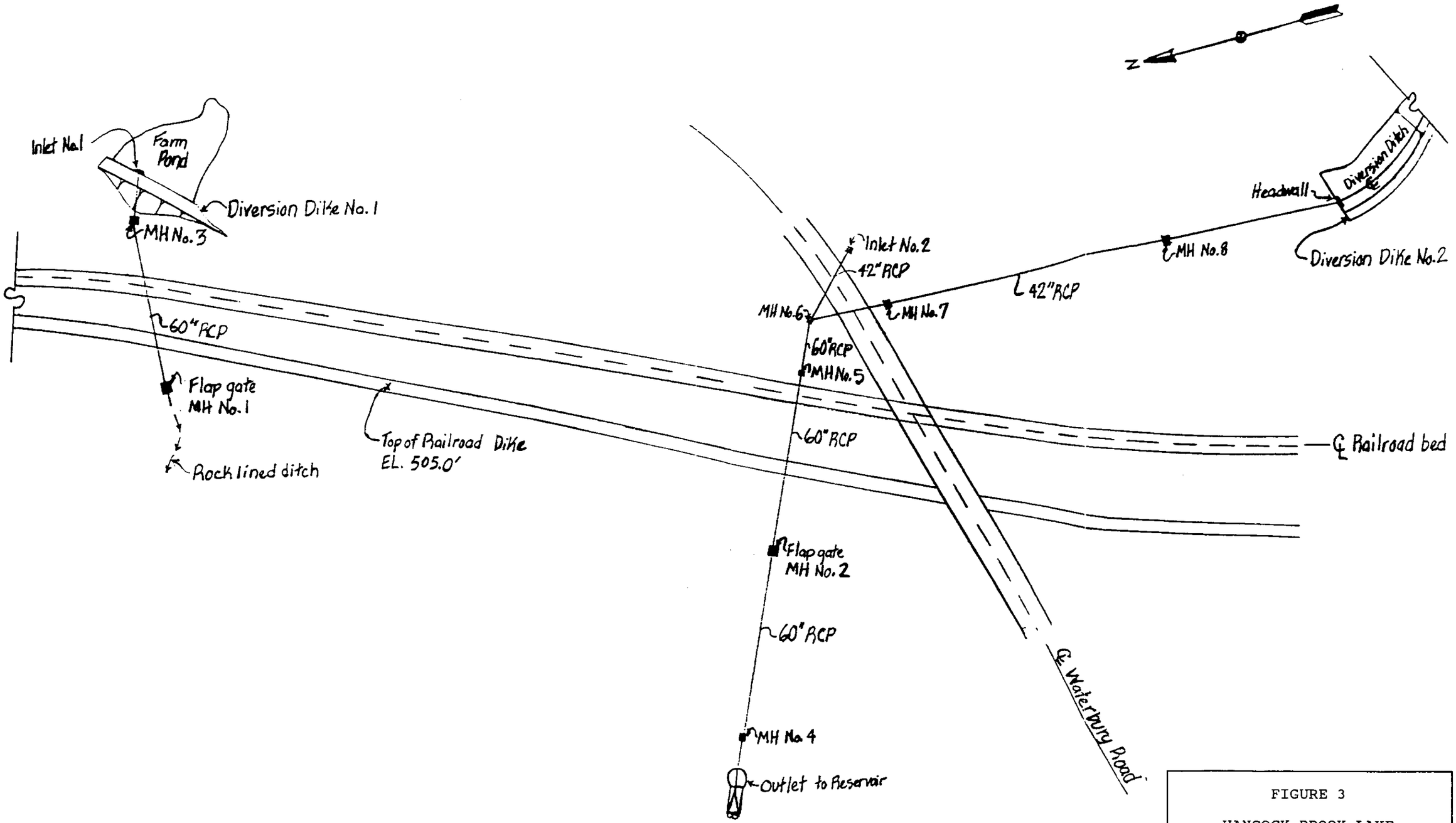


FIGURE 2



PLAN
N.T.S.

FIGURE 3

HANCOCK BROOK LAKE

CONFIGURATION OF DIKES

APPENDIX IV

INSPECTION CHECKLISTS

TEAM MEMBER CHECKLIST FOR PERIODIC INSPECTION NO. 5		
AREA EVALUATED	**BY**	**CONDITION**
CONCRETE/STRUCTURAL		
INLET STRUCTURE		
General Condition of concrete	FF	Good.
Spalling		Spalling on the top edges of walls and concrete near the gate operator.
Rusting or staining of Concrete		Minor staining on substructure concrete.
Visible Reinforcement		None.
Condition of Joints		Good.
Seepage/Efflorescence		Minor observed.
Cracks		None.
OUTLET STRUCTURE		
General Condition of Concrete		Good
Spalling		Minor.
Rusting or staining		Efflorescent staining.
Visible Reinforcement		None.
Condition of Joints		Good.
Seepage/Efflorescence		Leakage and efflorescence in horizontal construction joint above top of conduit headwall.
Cracks		Minor hairline cracks in both east and west walls.
STAFF GAGE BASES		
General Condition		Good.
Spalling		None.
Rusting or Staining		None.
Cracking	FF	None.

TEAM MEMBER CHECKLIST FOR PERIODIC INSPECTION NO. 5		
AREA EVALUATED	**BY**	**CONDITION**
CONCRETE/STRUCTURAL		
LOG BOOM	FF	
Logs		Good.
Anchorage		Good.
SPILLWAY		
General Condition of Concrete		Good.
Spalling		Minor spalling at edges
Rusting or Staining		None.
Visible Reinforcement		None.
Condition of Joints		Some minor joint deterioration
Seepage/Efflorescence		None.
Cracks		One transverse crack across east side of spillway.
SPILLWAY RETAINING WALL		
General Condition of Concrete		Good.
Spalling		Minor chips.
Rusting or Staining		None.
Visible Reinforcement		None.
Condition of Joints		Good.
Seepage/Efflorescence		None.
Cracks		None.
BUBBLE GAGE SHELTER		
General condition of concrete		Good.
Rust or staining		None.
Spalling		Minor.
Visible Reinforcement		None.
Seepage/Efflorescence		Minor near the stairs.
Condition of Joints	"	Good.
Cracks	FF	Hairline.

TEAM MEMBER CHECKLIST FOR PERIODIC INSPECTION NO. 5		
AREA EVALUATED	**BY**	**CONDITION**
CONCRETE/STRUCTURAL		
DIVERSION DIKE CONDUITS	FF	
General condition of concrete		No. 1 - Fair, No. 2 - Good.
Rust or staining		Staining at joints.
Spalling		Minor at ends of both pipes.
Visible Reinforcement		Visible at spalls.
Condition of Joints		Leaking. 1 1/2" wide transverse at end of No. 1.
Cracks		No. 1 - poor alignment, No. 2 - good, some leaking.
	FF	

TEAM MEMBER'S CHECKLIST FOR PERIODIC INSPECTION NO. 5		
AREA EVALUATED		CONDITION
MECHANICAL ITEMS		
a. WEIR SLUICE GATE		
1. General Condition	KP	Gate under water. Quality of visual inspection was poor. No deficiencies noted.
2. Manual Operator		Operated through a complete open/close cycle. Condition satisfactory.
b. FLAP VALVES		
1. Diversion Dike 1		Flap valve in good condition.
2. Diversion Dike 2	KP	Flap valve in good condition.

TEAM MEMBERS CHECKLIST FOR PERIODIC INSPECTION NO. 4		
AREA EVALUATED	**BY**	**CONDITION**
HYDROLOGY/HYDRAULICS		
Spillway	DM	
Approach		Clear, Minor vegetation
Control		Good
Exit		Clear, Minor vegetation
Outlet Works		
Inlet		
Trash Bars		Minor rusting
Gates		None
Air Vents		None
Outlet		
Conduit		Not Observed (high water)
Apron		Good
Exit Channel		Small stones 40 feet downstream
Instrumentation		
Rain Gage		None
Pool Stage Recorder		Good
Tailwater Recorder		None
Staff Gage	DM	Good

TEAM MEMBERS CHECK LISTS FOR PERIODIC INSPECTION NO. 5		
AREA EVALUATED	BY	CONDITION
GEOTECHNICAL		
DAM EMBANKMENT		
Crest Elevation	LF PY	El. 505.0 ft-NGVD.
Surface Cracks	JM	None Evident.
Pavement Condition		Good gravel surface road.
Intake Service Road		Good gravel surface.
Movement or Settlement of Crest		None evident.
Lateral Movement		None.
Vertical Alignment Horizontal Alignment		Good. Good.
Condition at Abutment and at Concrete Structures		Good.
Indications of Movement of Structural Items on Slope		None.
Trespassing on Slopes		None observed.
Sloughing or Erosion of Slopes or Abutments		None observed.
Rock slope Protection Riprap failures		Good. Some schist blocks weathered and decomposed.
Unusual Movement or Cracking at or near Toes		None observed.
Unusual Embankment or Downstream Seepage	LF PY	None observed.
Piping or Boils	JM	None observed.

TEAM MEMBERS CHECK LIST FOR PERIODIC INSPTECTION NO. 5		
AREA EVALUATED	BY	CONDITION
DAM EMBANKMENT con't		
Foundation Drainage Features	LF PY JM	D/S dumped stone fill in good condition. Drainage ditch heavy vegetation.
Toe Drains		None.
Instrumentation System		6 Crest Monuments. Mon 3 scraped top but ok. All mon's slightly higher than crest. 6 Piezometers installed in 1995.
Vegetation		
Upstream slope		Small trees/brush on toe.
Crest		None.
Downstream slope		None.
OUTLET WORKS - INTAKE AND OUTLET CHANNEL		
A. Intake Channel		
Slope Conditions		Good. Some trees & brush.
Bottom Conditions		Submerged.
Rock Slides or Falls		None.
Log Boom		Good.
Debris		None.
Drains or Weep Holes		None.
B. Outlet Channel		
Loose Rock or trees overhanging channel		Minor loose rock. Few trees on rock/concrete.
Condition of discharge channel	LF	Good. Small pile of stone across channel about 40' d/s from outlet.
Weep Holes	PY JM	Good.

TEAM MEMBERS CHECH LIST FOR PERIODIC INSPECTION NO. 5		
AREA EVALUATED	**BY**	**CONDITION**
SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS		
A. Approach Channel	LF PY JM	
General Condition		Good.
Loose Rock Overhanging channel		None.
Floor of Approach Channel		Few pine trees near reservoir. Some broken broken bottles on weir.
B. Discharge Channel		
General Condition		Good.
Loose Rock Overhanging Channel		Left side-fractured rock d/s of spillway sta 5+35.
Trees Overhanging Channel		None.
Floor of Channel		Some surface water runoff from channel walls. Some brush in channel.
Other Obstructions		None.
C. Safety Fence		Good condition. Material under two fence posts eroded.
	LF PY JM	

TEAM MEMBERS CHECK LIST FOR PERIODIC INSPECTION NO. 5		
AREA EVALUATED	BY	CONDITION
DIKE EMBANKMENT		
Crest Elevation	LF	El. 505.0 ft-NGVD
Surface Cracks	PY JM	None evident.
Crest Condition		Gravel surface-good.
Movement or Settlement of Crest		None Evident.
Lateral Movement		None Evident.
Vertical Alignment		Good.
Horizontal Alignment		Good.
Condition at Abutment		Good.
Trespassing on Slopes		None Evident.
Sloughing or Erosion of slopes or Abutments		None.
Rock Slope Protection Riprap Failures		Good.
Unusual Movement or Cracking at or Near Toes		None.
Unusual Embankment or Downstream Seepage		None observed.
Piping or boils		None observed.
Foundation Drainage		None.
Toe Drains		None
Instrumentation System		None.
Vegetation or Debris	LF PY JM	
Upstream Slope		Some brush on slope.
Crest		Minor grass growth.
Downstream Slope		Grass cover - good.
Toe		Clear.

APPENDIX V

SUMMARY OF INSPECTION NOTES

PERIODIC INSPECTION REPORT NO. 5
HANCOCK BROOK LAKE
SUMMARY OF INSPECTION NOTES

TABLE OF CONTENTS

APPENDIX V-A

CONCRETE/STRUCTURAL

PERIODIC INSPECTION REPORT NO. 5
HANCOCK BROOK LAKE
CONCRETE/STRUCTURAL FEATURES

1. FIELD INSPECTION

The concrete/structural portion of Periodic Inspection No.5 of Hancock Brook Lake, Plymouth, Connecticut was performed on 7 November 1995 by Mr. Francis Fung of Engineering Directorate. Major features inspected include the following:

- Storm Drains
- Spillway weir
- Spillway retaining walls
- Inlet Structure
- Outlet structure
- Bubble Gage Shelter
- Staff Gage Bases

2. EMBANKMENT

a. Main Dam. N/A

b. Dikes. The two 60" reinforced concrete pipes (RCP) that pass through the New York, New Haven and Hartford railroad dike, and associated steel flap gates and manholes were inspected.

(1) 60" RCP from Diversion Dike No. 1. The overall condition of the storm drain system is fair, and the flap gate (see photo A-1) has several deficiencies.

The steel flap gate frame was originally set too high. There is a 6"± difference in elevation between the pipe invert and the steel frame. As noted in the previous report, the water flowing under the frame has further deteriorated the concrete below the flap gate. There are also concrete spalls around the flap gate. The deterioration of the concrete will eventually cause the anchor bolts around the steel gate frame to loosen or dislodge.

The 1-1/2" wide circumferential cracks, as noted in the previous inspection, have not worsened, but a few more spots of exposed rebar inside the RCP have been located (see photo A-2 and A-3).

Water is leaking from various circumferential construction joints. An orange/rust colored material has developed at these locations (see photo A-4).

The three eight foot sections of the pipe downstream of Manhole No.1 are in fair to good condition. There are concrete spalls and exposed steel rebar around the downstream end of the pipe opening (see photo A-5).

(2) 60" RCP from Diversion Dike No. 2. The overall condition of the storm drain system is fair to good. The deterioration of concrete around the steel frame has not worsened from the previous inspection. The flap gate has a thin coat of surface rust but no other major steel section loss (see photo A-6). There are minor areas of exposed steel rebar. Leakage from the flap gate is present with an excess amount of orange/rust colored material (see photo A-7).

The downstream side of Manhole No. 2 is in good condition. There are only minor exposures of steel rebar and hairline cracks in the top of the pipe (see photo A-8). The pipe exits into the reservoir below normal water level, so the entire pipe length on the downstream side could not be inspected.

Pipes and manholes in other diversion dikes have not been inspected due to water level and confined space entry constraints. In future inspections, the storm drains should be inspected by both the structural and geotechnical engineers.

3. SPILLWAY

a. Weir. The overall condition of the concrete in the spillway weir is good. There are minor spalls along the upstream and downstream edges of the weir. The transverse

crack that was reported in the last report has slightly increased, but will not affect the integrity of the spillway weir (see photo A-9).

b. Retaining Wall. The overall condition of the spillway retaining walls appears to be good and shows no significant change from the previous inspection. Most bonding and alignment of joints show no sign of unusual movement. The chain link fence on top of the wall is in good condition.

4. OUTLET WORKS

a. Intake Structure. The spall on the top inside edge of the headwall was patched but there are various small spalls along the top edge of the headwalls. A concrete spall is located at the corner near the protective beams of the gate operator (see photo A-10). The tubular steel supports for the lower platform, which also serve as trash racks, are rustier than they were last inspection (see photo A-11). The trash racks should be repainted to prevent further deterioration.

b. Outlet Structure. The overall condition of the concrete in the outlet structure is good. The condition of three vertical cracks and one horizontal crack in the west wall has not worsened since the previous inspection. The amount of the efflorescence along the horizontal construction joint above the conduit and along the vertical crack extending the full height and width of the east wall has increased moderately since the last inspection (see photo A-12 and A-13). All weepholes are functioning properly, and the chain link fences on top of the outlet walls have only minor rust. The conduit was not inspected due to high water level. The next inspection of the conduit should be a physical inspection performed when the water level and temperature are acceptable.

5. PROJECT INSTRUMENTATION

a. Bubble Gage Shelter. The overall condition of the concrete and structure is good. The hairline cracks in the

northwest corner of the west face of the roof slab and the cold joint that extends around the entire perimeter of the roof slab have remained unchanged since the last inspection. The shelter stairs have settled approximately 1/2 inch, as indicated in the last inspection report (see photo A-14). The bottom edge of the metal door has rusted and it should be repainted (see photo A-15).

b. Staff Gage Bases. The overall condition of the concrete in the staff gage bases is good.

6. RECOMMENDATIONS

a. Dam Safety Items. None.

b. Normal Maintenance

(1) Repair and patch the noted concrete spalls at the inlet structure area. Estimated construction cost is $1,000.

(2) Remove efflorescence along the joints and seal cracks at the east wingwall of the outlet structure. Estimated construction cost is $3,000.

(3) Perform inspection of the outlet conduit when water level and temperature are acceptable. This inspection can be done by a structural engineer from Engineering Directorate.

(4) Project personnel should monitor cracks and check all deteriorated concrete areas in the 60" RCP concrete walls and manholes in Diversion Dike No. 1 and 2 annually.

(5) Project personnel should paint the metal door to the bubble gage shelter to prevent further deterioration.

APPENDIX V-B

MECHANICAL

PERIODIC INSPECTION REPORT NO. 5
HANCOCK BROOK LAKE
MECHANICAL

1. FIELD INSPECTION

The mechanical portion of Periodic Inspection No. 5 at Hancock Brook Lake was performed on 7 November 1995 by Mr. Kenneth Paton of Engineering Directorate.

2. EMBANKMENT

a. Main Dam. N/A

b. Dikes

(1) Diversion Dike 1 Flap Valve. The 60 inch diameter flap valve was visually inspected and no mechanical deficiencies were noted (see photo 1). See the structural comments for the condition of the reinforced concrete pipe at the valve and the valve frame.

(2) Diversion Dike 2 Flap Valve. The 60 inch diameter flap valve was visually inspected and no mechanical deficiencies were noted (see photo 2). See the structural comments for the condition of the reinforced concrete pipe at the valve and the valve frame.

3. OUTLET WORKS

a. Manually Operated Weir Sluice Gate. The manually operated sluice gate in the weir at the intake structure is normally left in the closed position, and is only used to dewater the pool. The gate was below the water during the inspection which permitted only a poor visual inspection. No deficiencies were noted. The gate was operated through a complete open/close cycle. The manual operator performed satisfactorily.

4. RECOMMENDATIONS

a. Dam Safety Items (No Mechanical Items)

b. Normal Maintenance

Recommend that project personnel annually lubricate the manual operator for the weir sluice gate, and semiannually operate the gate through a complete open/close cycle.

APPENDIX V-C

ELECTRICAL

PERIODIC INSPECTION REPORT NO. 5
HANCOCK BROOK LAKE
ELECTRICAL

There are no electrical features at this project.

APPENDIX V-D

HYDROLOGY/HYDRAULICS

PERIODIC INSPECTION REPORT NO. 5
HANCOCK BROOK LAKE
HYDROLOGY/HYDRAULICS

1. FIELD INSPECTION

The hydrology and hydraulic features of Hancock Brook Lake were inspected by David Margolis of the Water Control Division, Engineering Directorate. Major features inspected include the spillway, outlet and inlet works, and hydrologic monitoring equipment. Past operating experiences were also reviewed.

2. SPILLWAY

a. Approach. The overall condition of the approach channel is good with no major obstructions (photo 1). There are a few small pine trees near the junction of the channel and reservoir.

b. Control. The concrete spillway weir is in good condition with no major cracks or spalls that would affect hydraulic capacity (photo 2).

c. Exit. The spillway exit channel is in good condition with no major outgrowth of trees or vegetation which would obstruct flow (photo 3).

3. OUTLET WORKS

a. Approach

(1) Inlet Channel. The inlet channel is in good condition with no major obstructions. Partially submerged log boom appears to be in good working condition (photo 4). The channel bottom was not inspected.

(2) U-Shape Control Weir. The control weir is in good condition (photos 5 and 6).

(3) Trashracks. The trashracks appear to be in good condition with the exception of rust on the tubular steel supports for the platform. See Concrete/Structural Appendix IV-A for discussion and photos.

b. Conduit. The 3- by 4.5-foot outlet conduit was not observed during the initial inspection due to the depth and velocity of the water in the channel. A video inspection performed on 29 October 1986 was monitored by NED personnel and was the last inspection of this conduit.

c. Exit Channel. The exit channel was in good condition. There are several small stones across the channel about 40-feet downstream from the outlet (photo 7). Previous inspection recommended removal of these stones. However, after further inspection, the stones do not appear to obstruct flow, and the cost of removal is not justifiable.

4. PROJECT INSTRUMENTATION

a. Rain Gage. The project is no longer equipped with a rain gage.

b. Pool Stage Recorder. The pool stage recorder, which consists of a Sutron 8200A Data Collection Unit in the concrete bubble gage shelter, is in good condition. At the time of inspection, the pool level was at 7.4 feet (Elevation 461.4 feet NGVD).

5. RECOMMENDATIONS

a. Dam Safety Items. There are no hydrologic/hydraulic recommendations.

b. Normal Maintenance. There are no hydrologic/ hydraulic recommendations.

APPENDIX V-E

GEOTECHNICAL

PERIODIC INSPECTION REPORT NO. 5
HANCOCK BROOK LAKE
GEOTECHNICAL FEATURES

1. FIELD INSPECTION

Based on the visual inspection performed on 6 and 7 November 1995, the geotechnical features of Hancock Brook Lake Dam and Dike are in good condition. Major features inspected include the upstream toe and slope, the crest, the downstream slope and toe, access roads, outlet works, the spillway and its channels, all abutments, and all rock walls within the project limits. The geotechnical features were inspected by:

Laura Fraser, CENED-ED-GD, Civil Engineer
Paul Young, CENED-ED-GG, Geologist
John MacPherson, CENED-PD-P, Civil Engineer

At the time of the inspection, water was flowing through the outlet works, and the pool was impounded at elevation 461.1 ft-NGVD (7.1-foot stage).

The highest pool impoundment since the last inspection in 1990 was in June 1992 with a pool elevation at 470.1 ft-NGVD (stage 16.1 feet, and 24% full).

2. EMBANKMENT

a. Main Dam

Visual inspection of the dam embankment and abutment areas showed no indication of settlement, lateral movement, sloughing of slopes, significant irregularities or evidence of instability that would affect its performance. There is no apparent vertical or horizontal misalignment.

(1) Crest. The gravel on the crest of the dam is in good condition. There is no apparent sign of sloughing or cracking along the crest. Alignment of the crest is good. The last inspection report had noted the bubble gage structure stairs had settled about ½ inch. The rock protection around the structure appears to be in good condition with no indications of settlement.

(2) Upstream Slope. The slope is in good condition and appears stable with no indication of movement or sloughing (Photo 1). Stone quality is good but the size varies with an occasional weathered piece of schist

disintegrating to fine material. There are several small trees and brush beginning to take root at the toe of slope which should be removed. Trees allowed to grow can develop roots which could create seepage paths into the embankment.

(3) Downstream Slope. The downstream slope appears stable. The stone protection material on the surface is highly variable in size (Photo 2). There are numerous scattered schist blocks on the surface that have weathered to fines. There is no significant erosion of these fines at this time.

(4) Seepage. No piping, boils or sink holes were observed during the inspection or reported by the Project Manager. A small amount of standing water (1-2 inches) was noted in the crushed stone fill between the diversion drainage ditch and the downstream toe of the slope. Historically, there has been water accumulated in this area as it is surrounded by higher ground (Photo 3). The drainage ditch constructed to drain this area appears to have too flat a gradient or it may slope towards the dam.

(5) Drainage Ditch. The edges of the drainage ditch are overgrown with light brush making access along its length difficult. Light flow of water is visible where the crushed stone fill meets the drainage ditch. However, there is stagnant water at several sections along the ditch. As noted above, the drainage ditch appears to have too flat a gradient to afford complete drainage for the crushed stone fill. Also, the overgrowth may be causing some of the ponding. Where the drainage ditch meets the outlet channel there is an accumulation of settled material causing the water flow in this area to decrease further. Additionally, during times of high tailwater a reverse flow along the ditch may exist.

A parcel of land south-east of the ditch has been leased to the Town, and a soccer field has been constructed. On the day of inspection there were hay bales and a silt fence in place between the soccer field and the drainage ditch. Potential impacts of the soccer field on the drainage ditch appear minimal.

(6) Intake Service Road. The gravel-surface road from the dam crest to the inlet along the upstream slope is in good condition.

b. Dike. There are three dikes, whose features are discussed in detail in Periodic Inspection Report #3, dated 1985. A main dike runs parallel and west of the Penn Central

railroad tracks. It crosses Waterbury Road about 2,000 feet from the dam along the east bank of the reservoir. Two small diversion dikes are located on private property upland of the railroad tracks. Two 60-inch diameter concrete conduits run from the diversion dikes under the main dike and into the reservoir. The Corps' responsibility is limited to maintenance of the main dike and the two 60-inch pipes under the dike. The two diversion dikes were not inspected. An inspection of the two 60-inch pipes under the main dike was performed in December 1993. Evidence showed there may be voids around the outside of the pipes. A ground penetration radar study has been budgeted for FY-96 to determine the location and extent of the voids.

The main dike showed no indication of misalignment, settlement, or other evidence of instability that would affect its performance. Indications of abnormal seepage or sloughing of stone slopes were not observed during the inspection or reported by the Project Manager. The upstream stone slopes and gravel crest roadway are in good condition. Grass cover on the downstream slope is dense and well maintained. Vegetation on the upstream stone slopes is minor and should be kept under control.

3. SPILLWAY

a. Approach Channel. The approach channel is generally unobstructed. There are a few small pine trees near the junction of the channel and reservoir. There are broken beer bottles scattered around the concrete weir.

b. Discharge Channel. The channel is excavated in rock and is in good condition. There are large cracks in the left rock wall just past the weir (as noted in previous inspections). One small block of rock (approximately 2 ft by 2 ft) has slipped off the face since the last periodic inspection (Photo 4). Inspection of the concrete wall and the area above the rock showed no signs of movement. Also, there is no evidence that any large blocks of rock are moving as the original drill holes are still in alignment. Compared to photos from previous inspection reports, the rock shows no significant sign of movement.

The channel bottom is generally clear with scattered vegetation and brush. Approximately 100 feet downstream of the weir, the ground is wet and there is a small amount of flow towards downstream. Flow appears to be coming off of the right rock wall and through the ground. Where the discharge channel meets the downstream river, some water is backed up.

c. Safety Fences. The safety fences along the spillway approach and discharge channels appear to be in good condition. Two fence posts on the right side of the spillway discharge channel have had the material around their base erode away. Both fence posts are elevated and adjacent to forested land on the right side of the channel with very limited access to either side of the fence. The stability of the fence was not physically tested but appeared stable. There is also an opening under the fence between land east of the outlet discharge channel and the spillway discharge channel. This opening is not large but does allow limited access. It was apparently caused by natural settlement of the ground between fence posts.

4. OUTLET WORKS

a. Inlet Channel. The inlet channel is clear and in good condition. The rock slopes and concrete/rock contacts are in good condition. The steel structure holding the stop logs has some rust. The stop logs are in place and free of debris. Some small trees and brush have grown up around the safety fences and should be removed to prevent overgrowth around the intake (Photo 5).

b. Outlet Channel. The outlet channel is a shallow rock excavation in satisfactory condition (Photo 6). The rock/concrete contacts are in good condition. A tree has grown up between the concrete and rock abutment. The weepholes in the concrete wing walls were dry, but there were stains on the concrete indicating there was flow in the past. There are fractures in the right rock wall but, it is stable due to the favorable orientation of the rock structure. Some fractures in the left rock wall are inclined into the channel and some rock blocks have moved. However, failure of the slope would not significantly affect the function of the channel due to the low side wall height. A small section of loose rock sloughed down the embankment on the left rock wall of the outlet channel. Above this section of rock, soil beneath a fence post has eroded.

The channel bottom is generally clear with a few scattered stones. As noted in the previous inspection report, there is a pile of stones which extends across the channel 40 feet downstream of the outlet. This obstruction was not removed, but the pile of stones appears to have toppled somewhat. See Hydrology Appendix IV-D section for information on the hydraulic effects of this minor obstruction.

5. PROJECT INSTRUMENTATION.

Instrumentation to monitor embankment performance consists of crest monuments, control points, and piezometers. The crest monuments are all in working condition. Monument 3 appears to have been run over by a bull dozer but appears to be in working order. Control point, Mon A, had been damaged prior to the 1995 survey but was relocated during the survey. A complete discussion of the geotechnical instrumentation, interpretation, and evaluation of data are contained in the Instrumentation Appendix of this report.

6. RECOMMENDATIONS

a. Dam Safety Items. None at this time.

b. Normal Maintenance

(1) The small trees and brush along the upstream toe should be removed. Vegetation on the slope should continue to be removed.

(2) The vegetation in the drainage ditch should be removed to help increase flow in the ditch. Weeping willow trees or similar types could be planted downstream of the dam, at a distance greater than 15 feet from the downstream toe, to assist in drying up the wet area near the downstream toe.

(3) The downstream stagnant water is obscuring possible seepage observations. A survey along the drainage ditch centerline should be performed to determine the scope of work required to lower the ditch in order to drain the downstream toe area. Cost for the survey is estimated at $4,000.

(4) Based on the alignment of the drill holes, the rock mass in the left wall of the spillway shows no sign of movement. Fractures and joints in the rock appear stable. Project personnel should visit the site yearly to observe current conditions of the rock. The project manager should contact GED in the event movement of the rock is observed.

(5) Excess vegetation on the upstream and downstream slopes should continue to be controlled.

(6) Vegetation around the intake channel's safety fence should be removed to prevent overgrowth.

(7) A ground penetration radar study is budgeted for FY-96 to determine the location and extent of any voids around the two 60-inch pipes under the main dike to define the scope of work required to fix the pipes.

(8) The Instrumentation Appendix of this report indicates the performance of the dam is rated good. Recommendations include that excess vegetation should be removed to clear the line of site from the control points to Mons 1 and 6 and the piezometer water readings are to commence in February 1996.

APPENDIX VI

INTERMEDIATE TRIP REPORTS

PERIODIC INSPECTION REPORT NO. 5
HANCOCK BROOK LAKE
INTERMEDIATE TRIP REPORTS

There were no intermediate inspections since the last PI.

APPENDIX VII

INSTRUMENTATION DATA AND/OR PLOTS

Instrumentation Appendix
To Periodic Inspection Report No. 5

Hancock Brook Lake, Connecticut

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Instrumentation Appendix

To Periodic Inspection Report No. 5

Instrumentation For Safety Evaluation

1. Project Performance.

The dam performance is rated as good based on the visual observations and the analysis of the instrumentation data compiled to date. April 1995 crest monument data indicates minimal vertical movement (0.02 feet maximum) has occurred since the previous survey. Horizontal movement between 1989 and 1995 ranged from 0.19 to 0.37 feet. No piezometer data is available at this time. Water level readings are to commence in February 1996.

All elevations in this report refer to ft-NGVD.

2. General Project Description.

a. History.

Hancock Brook Lake Dam was constructed by the Corps of Engineers as one of 7 dams to provide flood control in the Naugatuck River Basin. The dam is located in Plymouth, CT, on Hancock Brook approximately 3.3 miles upstream of Hancock Brook's confluence with the Naugatuck River in Waterville, Connecticut. The drainage area just above Hancock Brook Dam is approximately 12 square miles. (Plate 1)

Construction of the rolled-earth fill type dam was completed in August 1966. The top of the dam is at El. 505 ft-NKVD, it has a total length of 630 feet and a maximum height of 57 feet above the stream bed. The upstream pool elevation is controlled by a concrete conduit 3 feet by 4.5 feet near the right abutment.

In addition to the dam, there is one dike located to the northeast of the dam.

b. Geology and Foundations.

(1) General. The dam is located in the western Connecticut highlands. It is an area where plateaus slope gently to the southeast and narrow sided bedrock controlled valleys dissect the plateaus. Advancing glaciers deposited glacial till on the lower slopes of the valleys while receding glaciers deposited alluvial material on the western and southern sides of the valleys. The bedrock varies between shales and limestones along the main axis of the Housatonic Valley and schists, granites, and gneisses along the Naugatuck Valley and tributaries.

(2) Site Geology. (Plates 3 & 4) Hancock Brook flows on a thick layer of alluvial gravels, sands and silts mixed with cobbles and boulders. Hills rise typically 200 to 400 feet above the river along the channel, which is approximately 175 feet wide at the dam site. Large boulders and blocks are scattered among bedrock outcrops on the right abutment. A drumloidal shaped hill which as extensive rock outcrops and extremely steep side forms the left abutment. Exposed bedrock at the dam site is a micaceous schist which is locally known as the Straits schist formation.

Overburden on the west abutment consists of highly variable deposits of glacial outwash overlying bedrock. The glacial outwash deposits are 2 to 15 feet thick and consist of silts, sands, gravels, and boulders. The deposits tend to be gravelly and silty in the spillway approach channel area and sandy in the spillway discharge area. The overburden beneath the river section rapidly increases in depth to thicknesses greater than 30 feet. It consists of highly variable deposits of sands and gravels with large boulders, overlain by silty sands. Overburden on the east abutment is approximately 15 feet thick at the dam centerline. It consists of glacial outwash sands and gravels which grade into sandy till midway up the abutment.

Under the dike embankment, one to 15 feet of glacial outwash overlies glacial till. The boring logs for the dike indicate that 14 to 40 feet of total overburden exist at the dike. The glacial outwash consists mostly at roughly stratified silts, sands and gravels with cobbles and boulders. The materials in the glacial till are mainly silty sands with cobbles and boulders.

The concrete spillway is founded on bedrock. The spillway abuts against the rock cut walls.

c. Dam and Appurtenant Structures Description. The dam is a rolled earth embankment with rock slope protection on both the upstream and downstream slopes. There is a 20-foot wide service road which descends from the crest at the east abutment and end lightly above the inlet structure on the upstream slope. The crest is 20 feet wide at elevation 505.0 ft-NKVD and has a total length of 630 feet. The dam consists of an upstream compacted impervious fill zone, a random fill core zone, a downstream pervious fill zone and two feet of stone protection underlain by two feet of gravel bedding. (Plate 6 & 10).

Hancock Brook Dam is an automatic retention basin which stores all floods which exceed the set conduit sluice gate opening. Flood control operation is not required. A permanent pool is maintained near a 6-foot stage (El. 460) during normal conditions.

The spillway is a 100-foot long trapezoidal section which is founded on bedrock. The crest elevation is at El. 484.

The outlet works consist of an intake channel, an intake structure, a 3 by 4.5 foot conduit, and outlet structure and outlet channel.

The dike is a rolled earth fill embankment approximately 2300 feet long with a crest elevation of El 505. The upstream slope is protected with 2 feet of stone protection and the downstream slope is grass.

d. Maximum Impoundments

(1) June 1982. In June 1982, the embankment was subjected to the highest impoundment to date with a maximum water surface of El. ±477.4 (stage 23.4 ft). There is no record of an official inspection done by Geotechnical Engineering Division. The periodic inspection report No. 3, dated October 1985, stated the dam and dike functioned in a satisfactory manner during the impoundment.

(2) April 1987. The second highest impoundment to date was in April 1987 with the upstream pool at El. 473.0 (stage 19 feet). The dam was inspected at the time of the flood by an Emergency Response Team from Geotechnical Engineering Division. The embankment appeared to perform satisfactorily under the new pool conditions. No abnormal seepage conditions such as piping, boils, or sinkholes were observed then by the team or subsequently reported by the Project Manager.

3. Instrumentation.

Instrumentation to monitor embankment performance consists of 6 piezometers, 6 crest monuments and 2 survey control points (Plate 5).

a. Crest Monuments. Six crest monuments (Mon 1 - 6) were installed in Hancock Brook Dam in June 1985. They are located on the downstream edge of the dam crest (Plate 5). The depth and composition of the monuments is a 10-foot deep by 3.5-inch diameter steel pipe filled with concrete and capped with a brass disk. The 1990 periodic inspection reported that the top of Mon 3 had a slight bend. The 1995 periodic inspection observed the same bend but the monument had also been scraped by a bulldozer. The two survey control points (Mon A & B) are located downstream of the dam and are assumed to be fixed reference points. The initial survey was performed in September 1985 with subsequent surveys done in January 1989 and April 1995. All surveys were performed by the New England Division COE Surveyors using and electronic distance meter (EDM) instrument.

b. Piezometers. A total of 6 piezometers (3 double) were installed at Hancock Brook Lake Dam in Summer 1995 by the Mobile District. The piezometers are Casagrande type tips with 3/4-inch PVC riser pipes.

A piezometer chart of information listing location, piezometer tip elevation, and the zone/material where the tip is located and location plan are shown on Table 1.

4. Data Collection, Interpretation, and Evaluation.

a. Crest Monuments.

(1) Data Collection. The results of the crest monument surveys performed between 1985 and 1995 are shown on Plates 8 & 9. Computed vertical and horizontal movements of each monument are shown on Table 2 and are also plotted and shown graphically on Plates 8 & 9.

(2) Interpretation and Evaluation. The April 1995 survey performed used an electronic distance meter (EDM) with Third Order, Class II accuracy (1:5000) for horizontal measurements and Third Order, Class I accuracy (1:10,000) for vertical measurements according to the standards and procedures outlined in Attachment No. 1.

The survey data between 1985 and 1989 shows a general settlement of all monuments of less than 0.02 feet (0.24 inches); with the maximum settlement occurring at Mon 4. Between 1989 and 1995 a general heave of all monuments occurred. Maximum vertical heave between these two subsequent surveys was 0.02 feet (0.24 inches) at Mons. 1, 2, & 4. Vertical movements of this small magnitude can be considered negligible when taking into account the margin of error of the survey.

Horizontal movement between 1985 and 1989 ranged between 0.10 and 0.13 feet (maximum occurring at Mon 1) and appeared to be northward and upstream in direction. Between 1989 and 1995 the general direction of all monuments appears to be in a southeast and downstream direction (Plate 9). The horizontal movement ranges between 0.19 and 0.37 feet with the maximum movements occurring at Mons 1 and 6. (see Table 2). This movement can be attributed to the fact the dam has been loaded in the downstream direction. There were no signs of damage to the monuments and no evidence to show a significant movement of the dam. Movement of the survey monuments can be attributed to natural movement of the dam from the upstream loadings and instrument error. The maximum movement at Mons 1 and 6 could also be attributed to the survey data. During the survey, Mons 1 and 6 could not be sited from a second set up due to vegetation overgrowth and therefore northing and easting coordinates could not be averaged like the other monuments had been.

b. Piezometers.

(1) Data Collection.

(a) Reading Schedule. Piezometer monitoring at Hancock Brook Lake Dam is performed by project personnel. The minimum piezometer reading schedule presently in effect is as follows:

Routine. During the periods when the reservoir is at or below the 17-foot stage (El. 466.0 ft-NGVD) readings should be made by the project manager at least once a month. When access to the instruments is made hazardous by snow or ice, the readings may be deferred until safe access is possible.

High Pool. During periods when the pool stage is at or above the 17-foot stage (including and rising and falling pool), readings should be made on a daily basis. Pool stage and tailwater elevations should be recorded simultaneously with piezometer readings. On a falling pool, piezometer readings should continue for approximately five days after the pool has returned to its normal stage.

(d) Special Conditions. If unusual changes in readings develop or if piezometers become inoperable, Geotechnical Engineering Division (GED) should be contacted.

(2) Interpretation and Evaluation. Plate 11 shows the location of the piezometers along the cross section. Due to inoperable water level indicators, no readings have been taken as of the date of this report. Readings shall commence in February 1996.

5. Conclusions and Recommendations.

a. General. Instrumentation at Hancock Brook Lake Dam consists of crest monuments and piezometers. All instrumentation appears to be functioning properly.

b. Crest Monuments.

(1) Schedule. The schedule of crest monument surveys at Hancock Brook Lake Dam is once every five years to coincide with the periodic inspection schedule. The next scheduled survey is to be performed in FY-2000. If unusual readings are obtained during the next survey or if field evidence of embankment movement is discovered, the monitoring schedule will be adjusted as needed.

(2) Evaluation of Adequacy. The maximum vertical movement between subsequent surveys recorded is 0.02 feet (0.24 inches). This movement is small and could be attributed to

survey error, actual movement of the dam (negligible), or heave from frost action of the monument itself.

Horizontal movement between subsequent surveys ranges between 0.010 and 0.37 feet (1.2 - 4.4 inches). The higher movement could be attributed to survey error and unattainable data. It seems unlikely to get a 4.4 inch movement with such minor vertical movement.

The present configuration and number of crest monuments and control points are considered adequate to monitor horizontal and vertical movement of the dam embankment. The vegetation in the line of site from both control points to the crest monuments should be kept clear for future surveys.

With the advent of Global Positioning Systems Survey (GPS), such as NAVSTAR, the accuracy of three-dimensional movements can be detected at levels of less than 5 millimeters (Ref 1110-1-133). The implementation of this type of monitoring system is recommended if it proves to be cost effective.

c. Piezometers.

(1) Schedule. The current piezometer reading schedule as outlined in paragraph 4.b of this report should continue to be implemented by project personnel.

(2) Evaluation of Adequacy. At this time, the number of piezometers is adequate to monitor the groundwater flow.

TABLE 1
HANCOCK BROOK LAKE DAM
PZ DATA

PZ	SURVEY TOP ELEV	PZ TIP ELEV	STATION	OFFSET (FEET)		ZONE OF INFLUENCE	MATERIAL TYPE
1A	485.19	429.59	7+25	95	U\S	FOUNDATION CUT OFF	med-coarse SANDS w/silt
1B	485.33	457.33	7+25	95	U\S	IMPERVIOUS FILL	silty SANDS
2A	403.59	424.69	7+25	20	U\S	FOUNDATION	coarse SANDS & GRAVELS
2B	403.66	451.66	7+25	20	U\S	RANDOM FILL	silty SANDS
3A	461.06	420.16	7+25	124	D\S	FOUNDATION	SANDS & GRAVELS near bedrock
3B	461.12	449.12	7+25	124	D\S	DRAINAGE BLANKET	GRAVELS

TABLE 2
Hancock Brook Lake
Survey data

	Y	X	
September 1985			
Mon	northing	easting	elevation
1	287312.8600	521499.2500	505.58
2	287354.0800	521407.2300	505.28
3	287395.2100	521317.6600	505.64
4	287436.6700	521226.0000	505.52
5	287476.9400	521134.6500	505.71
6	287509.4400	521041.3400	505.35

January 1989			
Mon	northing	easting	elevation
1	287312.9500	521499.3400	505.57
2	287354.1300	521407.3300	505.27
3	287395.3000	521317.7400	505.63
4	287436.7800	521226.0300	505.50
5	287477.0500	521134.6600	505.70
6	287509.5400	521041.3300	505.35

1989-1985 delta n	delta e	delta elev. (ft)	resultant (ft)	resultant (in.)
0.09	0.09	-0.01	0.13	1.53
0.05	0.1	-0.01	0.11	1.34
0.09	0.08	-0.01	0.12	1.44
0.11	0.03	-0.02	0.11	1.37
0.11	0.01	-0.01	0.11	1.33
0.1	-0.01	0	0.10	1.21

April 1995			
Mon	northing	easting	elevation
1	287312.5856	521499.3651	505.59
2	287353.9328	521407.3384	505.29
3	287395.0968	521317.7682	505.64
4	287436.5990	521226.0746	505.52
5	287476.8877	521134.7741	505.71
6	287509.3471	521041.5520	505.36

1995-1985 delta n	delta e	delta elev. (ft)	resultant (ft)	resultant (in.)
-0.27	0.12	0.01	0.30	3.57
-0.15	0.11	0.01	0.18	2.19
-0.11	0.11	0.00	0.16	1.88
-0.07	0.07	0.00	0.10	1.24
-0.05	0.12	0.00	0.13	1.62
-0.09	0.21	0.01	0.23	2.78

Control Pt	northing	easting	elevation
A	286920.7783	521214.0174	NR
NEW A	286921.1594	521213.6654	NR
B	286863.9294	521020.1903	NR
BM C	NR	NR	509.87

1995-1989 delta n	delta e	delta elev. (ft)	resultant (ft)	resultant (in.)
-0.36	0.03	0.02	0.37	4.38
-0.20	0.01	0.02	0.20	2.37
-0.20	0.03	0.01	0.21	2.46
-0.18	0.04	0.02	0.19	2.24
-0.16	0.11	0.01	0.20	2.38
-0.19	0.22	0.01	0.29	3.53

Note:
April 1995 Survey: Mons 1 & 6 could not be sited from a second set up due to overgrowth. Northings and eastings for Mons 1 & 6 are NOT and average.

ATTACHMENT NO. 1

STANDARDS FOR SETTLEMENT SURVEYS

1. Control points are stamped brass disks preferably set in a ledge area. Where no ledge is available, they are set in concrete bounds placed flush with the ground.

2. Control points are set in areas such that the maximum possible number of crest monuments on the dam are visible.

3. Control points are tied into four reference points by distance. This provides a check each time they are occupied for settlement surveys or allow them to be replaced if found to be destroyed.

4. Distances are read and recorded between settlement bounds. Both distance and angle are read and recorded from the control points that are being occupied to locate each settlement bound on the dam.

5. In locating each settlement bound, a control point will be occupied setting 0-00'-00" (referenced line of site) on a second control point, reading and recording both interior and exterior angle closure, along with distances through each settlement bound located on the dam. Each settlement bound is located from a minimum of two control points. These locations are third order, class II survey with relative accuracies of not less than 1 part in 5,000.

6. Levels are run from control points through each settlement bound on the dam with a return run back into the control points to check the elevation closure on the run. Closure tolerance should be no greater than 0.05 feet. These levels are third order, class I survey with relative accuracies no less than 1 part in 10,000.

7. Crest monument surveys are performed using Topcon EDM Total Stations and recording both horizontal angles and horizontal distances.

PROCEDURE FOLLOWED FOR SETTLEMENT SURVEYS

The horizontal and vertical monitoring plan for settlement bound movement points employed a combination of triangulation and trilateration angle and distance techniques to survey the control network. Control points, in the form of stamped brass disks, were placed off the dam structure in areas from which the entire length of the dam is visible. Settlement bounds themselves, with stamped brass disks, were placed on the control points. Horizontal coordinates of the control points are based on the State Plane Coordinate System. Elevations of the control points are based on the National Geodetic Vertical Datum (NGVD).

Control points are occupied utilizing an EDM Total Station; observed distances and angles (interior and exterior angles), between control points and settlement bound establishing permanent bench marks. Standard leveling techniques are followed. Levels are double run and the means of the front and back runs were computed and recorded.

DATA ADJUSTMENT

A combination of triangulation and trilateration surveying techniques are applied. Each crest monument is located from two control points whereby two sets of coordinates are calculated using adjusted field angles and compliments and EDM distances. The two sets of coordinates are averaged to give a net result. The averaged coordinates are then established on each settlement bound for use in determining shifts in the dam surface structure over a period of years by comparing repetitive surveys.

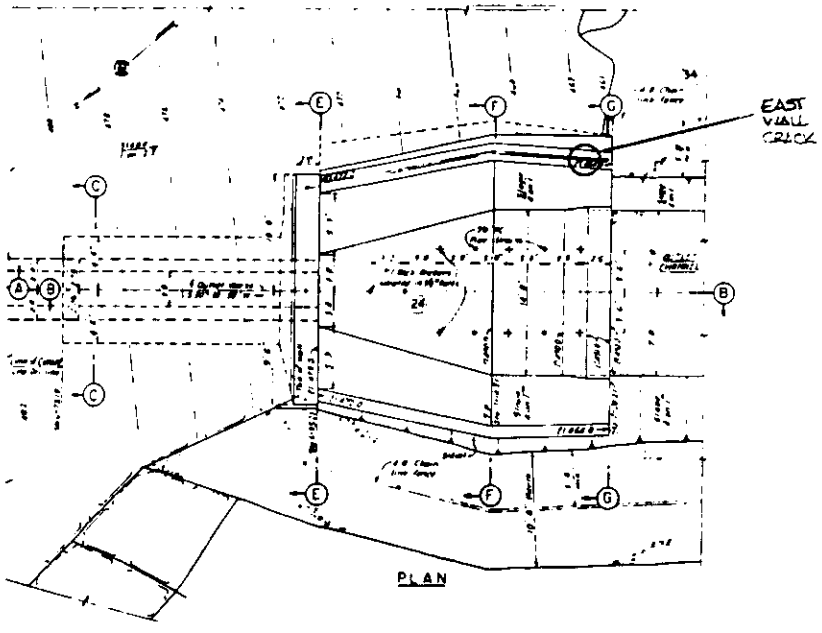
APPENIDX VIII

RESULTS OF CRACK SURVEYS

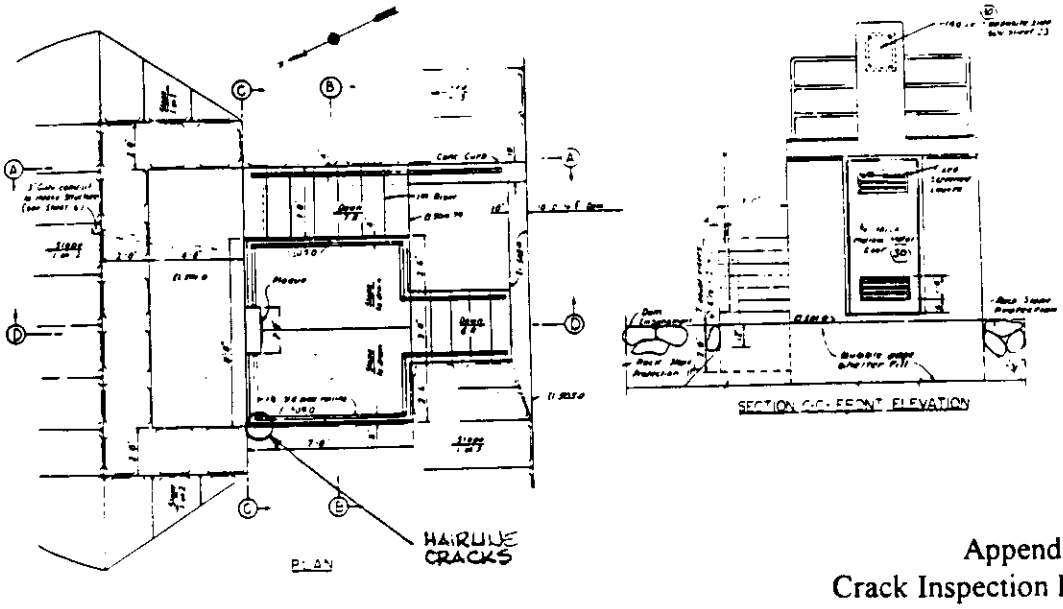
HANCOCK BROOK LAKE - CRACK INSPECTION RESULTS

1. Outlet Structure
   a. West Wall. 3 vertical and 1 horizontal crack
   hairline to 1/8" wide, unchanged since last inspection

   b. East Wall. 1/8" wide vertical crack through wall (see App. II, photo A-13)

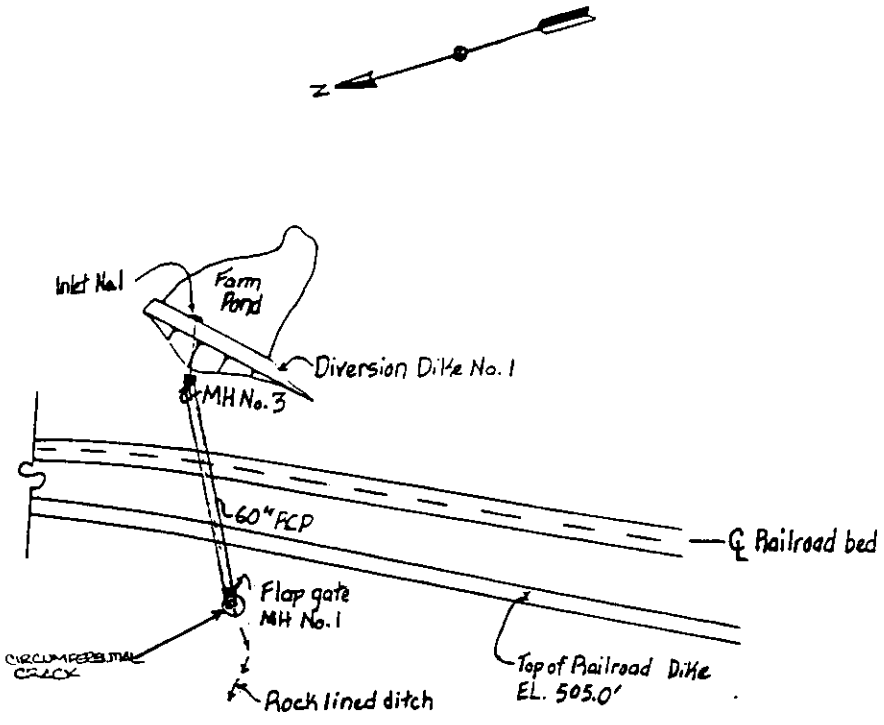


2. Bubble Gage Shelter
   a. Roof Slab. Hariline cracks in NW corner of west face of slab. Cold joint crack around perimeter of roof slab.



HANCOCK BROOK LAKE - CRACK INSPECTION RESULTS

3. Diversion Dike No. 1
   a. 60" RCP Outlet. Circumferential crack 1 1/2" wide at outlet just inside steel frame (see App. II, photo A-2).



PLAN
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APPENDIX IX

STATUS OF PROJECT DOCUMENTATION

PERIODIC INSPECTION REPORT NO. 5
HANCOCK BROOK LAKE
PLYMOUTH, CONNECTICUT

1. STATUS OF PROJECT DOCUMENTATION

a. Reference ER 1110-2-100 (15 February 1995), Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures states that engineering data related to project features will be collected and permanently retained in accessible, appropriate files at the project site. The data should consist of, but not be limited to, design memoranda, subsurface exploration results, as-built drawings and pertinent construction records including foundations and embankment criteria reports, contract specifications, emergency plans, etc.

b. Due to limitations at this site, project data consisting of as-builts, plans and specifications, design memoranda, emergency plans, etc. are accessible in the files located at the Hop Brook Dam project office.

APPENDIX X

STATUS OF DAM OPERATION MANAGEMENT POLICY (DOMP) TRAINING

PERIODIC INSPECTION REPORT NO. 5
HANCOCK BROOK LAKE
PLYMOUTH, CONNECTICUT

STATUS OF DAM OPERATION MANAGEMENT POLICY (DOMP) TRAINING

a. Reference ER 1130-2-419 (18 May 1978), Dam Operations Management Policy states that Division Engineers are directed to implement a dam safety training program for O&M personnel, with retraining every four years, that will address the following:

(1) Discussion of basic typical design considerations for various types of construction, including hydraulic considerations, foundation factors, etc.

(2) Procedures for monitoring potential problem areas.

(3) Dam safety features in design and construction.

(4) Normal operation, surveillance, monitoring and reporting procedures.

(5) Emergency Operations, surveillance, monitoring and reporting procedures.

b. DOMP training for the Naugatuck River Basin, which includes Hop Brook Dam personnel, was last conducted on 25 March 1992. Continued DOMP training throughout New England Division has not received funding in the last three years, but is scheduled to begin again in FY96.