Fourth Inspection Report
of the
New England Power Company
Deerfield River Project
Harriman and Sherman Developments
Project No. 2323
June 1982

Inspection and Report
by
CHAS. T. MAIN, INC.

MAIN

MAIN

CHAS. T. MAIN, INC.
PRUDENTIAL CENTER, BOSTON, MASSACHUSETTS 02199 • TELEPHONE 617 262 3200

June 29, 1982 1270-96-1

SUBJECT: Fourth Inspection Report
New England Power Company
Deerfield River Project
Harriman and Sherman Developments
Project No. 2323

Mr. Denton E. Nichols
New England Power Service Company
25 Research Drive
Westborough, MA 01581

Dear Denton:

We are pleased to submit our report on the fourth Five Year FERC Safety Inspection for the Harriman and Sherman Developments of the Deerfield River Project. This report covers our inspection of the project carried out in accordance with Part 12 FERC Order No. 122, effective 21 January 1981.

The project inspection and preparation of this report was done under the direction of the undersigned. Your assistance, and the assistance of your staff in conducting the inspection and assembling project data, is gratefully acknowledged.

We certify that all work performed in connection with the inspection and investigation of this project and preparation of this report was done in compliance with Part 12 of FERC Order No. 122.

Respectfully submitted,

CHAS. T. MAIN, INC.

Alton P. Davis, Jr., P.E.
Project Manager

Thom L. Neff, P.E.
Project Engineer

TLN:pel

TABLE OF CONTENTS

NEW ENGLAND POWER COMPANY

DEERFIELD POWER PROJECT

HARRIMAN AND SHERMAN DEVELOPMENTS

FERC PROJECT NO. 2323

1. GENERAL

Previous Federal Energy Regulatory Commission (FERC) safety inspections of these developments, performed in accordance with FERC Order 315, took place in September 1968; March and June 1973; and March, May and June 1978. A separate inspection of the power tunnel and surge tank at Harriman took place in March 1978. The effective FERC license date for this project is 1 April 1962.

To avoid unnecessary repetition, the reader is referred to the 1968, 1973 and 1978 reports for project history, descriptive drawings of structures, evaluation of adequacy of project spillway and stability analysis of structures. In addition, during 1981 and 1982, major field and laboratory investigations, along with static and seismic stability evaluations, took place at both Harriman and Sherman Dams. Reference is made to the results of these studies in the following MAIN reports, completed with the assistance and cooperation of Geotechnical Engineers, Inc. (GEI):

1. Summary of Static and Seismic Stability Analyses, Harriman Dam, New England Power Company, May 1982.

2. Summary of Static and Seismic Stability Analyses, Sherman Dam, New England Power Company, June 1982.

This report presents findings of the fourth FERC Safety Inspection of the development required at a maximum of five year intervals and was performed in accordance with Part 12 of FERC Order No. 122, dated 21 January 1981. Due to the investigations noted above, FERC requested that this report be submitted at an early date.

2. PROJECT DATA

For pertinent project statistical data, reference is made to the September 1966 report and Appendix A of the October 1973 report. Details of field instrumentation installed at Harriman and Sherman Dams in 1981, and a description of the improvements to Harriman Dam in 1981 appear in the May 1982 and June 1982 stability reports.

3. FIELD INSPECTION

The project structures were inspected on 2 June 1982 by Messrs. Alton P. Davis, Jr., Thom L. Neff and William H. Walton of Chas. T. Main, Inc. (MAIN), accompanied by Messrs. Hugh W. Sullivan, Leo P. Corey and Charles M. Harrington from the New England Power Company (NEPCo), and Mr. Denton E. Nichols from New England Power Service Company (NEPSCo). Water surface elevations at the time of inspection were approximately as follows:

Harriman

- headwater: 1382.0 feet
- tailwater: 998.0

Sherman

- headwater: 998.0 feet
- tailwater: 920.1 feet

The assistance of Mr. Denton E. Nichols and Mr. Leo Corey in conducting the inspections and collecting and furnishing performance data is gratefully acknowledged.

An inspection of the exterior of the Harriman intake tower and morning glory spillway was conducted by Mr. Davis and the NEPCo staff on 24 March 1982 with the reservoir elevation 1330.6.

4. FIELD INSPECTION OUTLINE

For the scope and outline of the field inspection, see the 1968 report. MAIN included in their work tasks, the items listed in Section 12.35 (Specific Inspection Requirements) of FERC Order No. 122.

Special attention was directed during this inspection to the new stability berm placed at Harriman Dam, the spillway flashboard systems at both dams, and the new seepage collection systems at the downstream toe of Harriman Dam.

In addition, evaluation was made of the Emergency Action Plans for both facilities, and the plans were discussed with the plant operators.

5. RESULTS OF THE FIELD INSPECTION

A. General

1) Harriman Dam - To avoid undue repetition in this text, only changes or previously unreported conditions will be highlighted in the following sections. The improvements to the dam and the new piezometers in the dam constitute the only significant facility modifications, and they are treated in great detail in the 1982 Harriman Stability Report.

2) Sherman Dam - The stipulation noted above also applies to the inspection of Sherman Dam. The only significant facility modification occurring at Sherman since the last report consists of the new piezometer installations in the dam, and they are described in the 1982 Sherman Stability Report.

B. Harriman Development

1) Powerhouse - The undersides of the penstocks were inspected and found in good condition. The drains running upstream from beneath the penstocks were dry in Units 1 and 2, but flowing 1-2 gpm in Unit 3. On Page 10 of the 1978 Report, "intermittent leakage" notes were found by NEPCo to be leakage from a defective fireline pipe joint, and when repaired, the leakage has stopped.

The upstream west corner shows a small amount of seepage. The upstream wall at the generator gallery level shows no cracks or seepage. Unit 1 turbine pit has a diagonal crack in the upstream corner of the barrel. Unit 1 was rewound and restored to service about May 1, 1982, but burned a stator coil in late May.

A crack similar to that in Unit 1 appears in the barrel of Units 2 and 3, but less pronounced. In general, cracks and spalls are extremely minor.

The exterior brickwork remains in excellent condition, while the left downstream lower wall (concrete) has craze cracking on its face. A calcite joint over Unit 3 tailrace shows some concrete deterioration.

A new powerhouse roof was installed in 1979 based on a 1978 recommendation to remedy roof cracks.

2) Yard Area - The retaining wall on the access road to the powerhouse has significant craze cracking, however, it is not related to project safety. There is some potential to affect access to the powerhouse if this wall becomes distressed. Numerous calcite deposits were seen on the wall.

The natural ground rises behind the powerhouse, giving the potential for seepage toward and under the structure; however, no evidence of adverse seepage was noted.

3) Waterways - Because so little changes were seen in past inspections of the power tunnel, penstocks and surge chamber, these areas are now drained and inspected at ten year intervals. The next inspection is due in 1988. They were not seen during this inspection because of the watered-up condition.

Photos No. 6, 7 and 8 in Appendix A depict details of the powerhouse area.

4) Dam, Intake and Spillway - Pictures depicting key features of the dam and intake appear in Photos No. 1-5 in Appendix A. The crest was re-leveled and sealed with a bituminous surface following the 1979-80 drilling program; however some recent distress has occurred during the

drilling program. There was no apparent crest settlement or alignment changes along the surface. Final cleanup of 1981 construction is underway and the downstream slope of the dam below elevation 1370 was being dressed for seeding and mulching. All underdrain weirs were relatively dry. Some local heavy surface erosion took place along the embankment which was due to rainfall and snow melt during the winter, but this has been redressed. No distress was seen in the overlay.

The upstream riprap generally appears in good condition, but grass and brush growth inhibit inspection in some areas. The drainage ditch on top of the new berm needs additional slope modification to permit better surface drainage.

The right abutment marshy area at elevation 1300 shows the same total seepage at the new headwall (to downslope culvert) as prior to the study work and drilling program begun in 1978. The marsh area backfill remains in good condition. Below the elevation 1300 bench, the original sideslope seepage from the terrace sand and gravel layer remains as before construction.

We did not inspect the spillway discharge tunnel because of water conditions.

The intake structure and lower bypass valve chambers were in generally good condition. The valves and pipes were also in good condition. Two cradles and pipe collars have been added under each span of the discharge pipe to improve structural capability. The upstream tunnel plug has heavy calcite buildup, but this is not excessive considering its age. Ladders down to the gallery are in good condition, but lack safety railings due to confined spaces. The bypass valves were repiped in 1981 for remote operation, if ever required. Concrete on the interior chamber walls is in good condition, but with light seepage. Intake House brick needs new pointing.

On 24 March the trash racks were generally in good condition above elevation 1385 and below 1340. The intervening racks were in various stages of corrosion with several holes near elevation 1375-80 and some bent bars near elevation 1345. In many areas the bars were effectively rusted through. NEPCo has standby plans to replace the racks above elevation 1340 which will be activated when necessary. The plans involve removal of the racks above elevation 1340± and installing a new hinged section at that elevation to go in over the gate slot area. There is new concrete to elevation 1355 inside the racks to rehabilitate old spalled concrete.

Above elevation 1355 several lift joints are spalled on the right inside of the trash rack area. The exterior intake concrete faces are in good condition.

The glory hole spillway surface appears generally in good condition, with the exception of the southeast quadrant where significant spalling has occurred. The relief drain outfall on the north side of the spillway throat (elevation 1375) appears to operate in excellent fashion. This detail consists of a box drain around the throat liner with drill holes into the bedrock. The rock face south of the spillway is heavily fractured and shows potential for large blocks of loose rock to fall toward the glory hole. Periodic inspections should be made of this area as in the past to note any unsafe conditions and removal of same, if necessary. The structural steel painting and surface treatment of walkway timbers all appear in generally good condition, with only very minor touchup or repair needed.

On 24 March the underside of the spillway elevation 1386 crest was inspected. A fairly consistent set of horizontal cracks were observed under the deck next to the vertical throat of the spillway. These cracks are old and do not impair the structures stability or performance. The lower piers supporting the spillway crest slab were in good condition and the concrete was sound. Some surface deterioration was observed on the

three northern piers with the center pier most eroded. This is possibly due to ice action and/or wave-induced wet/dry cycling over the years. Some rebar was locally exposed but this damage is not considered critical at this time. The walkway crest bridge was in good condition, as were the stop log guides. Concrete repairs to the bridge support piers (1-1/2 piers) c. 1978 were in good condition. Some of the piers (southeast corner) show localized deterioration.

C. Sherman Development

1) Powerhouse - Photos pertaining to the Sherman Powerhouse appear in Appendix B (Nos. 6, 7 and 8). The left abutment wall toward the penstock shows cracks in the foundation wall, one under the upstream window, others at each vertical offset in the concrete wall. These are likely resulting from thermal stressing. Light water staining appears on the floor near the upstream 1/3 point of wall. All cracks have been sealed with silicone sealant and are now dry.

Page 15 of the 1978 report indicated 0.48 feet differential settlement in the structure foundation. This is incorrect and should read 0.48 inches.

The draft tube door appears in excellent condition. Some seepage has occurred from a ceiling crack 2 feet downstream of the draft tube access gallery (now dry). The remainder of the lower gallery is in good condition.

Freeze-thaw distress was observed on the concrete lower powerhouse wall at the waterline. This does not appear serious, but needs continual monitoring.

The rear interior wall of the powerhouse shows a few very minor vertical cracks, but no seepage. The structural steel and powerhouse interior are in excellent condition and well maintained. The plant brickwork and tile roof remain in excellent condition.

2) Yard Area - Seepage comes off the slope behind the powerhouse and collects at the base of the low retaining wall. The retaining wall shows evidence of slow movement toward the powerhouse. Improving drainage in this area would improve the overall stability of the slope and powerhouse area. The culvert behind the powerhouse continues to flow about 5 gpm (clear water). The drain just behind the powerhouse flows at much less than 1 gpm, also clear.

3) Dam, Spillway and Intake - Photos No. 1-5 in Appendix B depict key features of the dam intake and spillway areas.

No dips or sags appear on the embankment slopes. Grass and brush growth inhibits inspection of the upstream riprap in some areas, though it appears in generally good condition.

The intake racks are in good condition, and the brick intake house shows no significant deterioration. The concrete cribwall upslope of the intake house does show some deterioration. Concrete training walls below the penstock intake are spalled to a depth of 6 inches, with several rebars exposed on the right wall. Less exposed rebar is seen on the left. This training wall condition is not critical to the wall stability or the intake at this time.

The crest pavement shows minor cracking, probably from traffic loads as well as weathering.

The flashboards on the spillway remain tight, while the mass concrete and lift joints appear in good condition. Rock in the spillway channel, though jointed, appears in generally good condition. Some surficial erosion of the right downstream slope has occurred, but does not present a problem.

The alignment of the downstream retaining wall left of the diversion tunnel shows no evidence of movement. The third block down from the top of the dam has a vertical crack at mid-span.

The spillway bridge concrete curbs from the right abutment that spans the spillway has spalling and cracking that requires attention.

The bypass tunnel was not readily accessible for inspection due to a protective steel grillage covering its opening. Only small flows exit from this structure.

D. EMERGENCY ACTION PLANS

The Emergency Action Plan telephone numbers have been tested within the last two months for an update. A test of the plan using a simulated failure of Searsburg was conducted and tested all the way through to FERC.

The Radiological Response Plan was tested by Yankee Rowe this year. The hydro-system was not notified quickly enough, however, this problem has been corrected.

The plans were discussed with the system operators who were found to be knowledgeable of their contents and the conditions under which they should be implemented.

6. MONITORING PROGRAMS

Monitoring programs with numerical pore water pressure data began with pneumatic piezometer installation at Harriman in 1979 and Sherman in 1981. Sample plots of this data appear as Figures 1 and 2, respectively.

A complete discussion of the resulting data from these monitoring units is found in the 1982 stability reports for both dams. The piezometer readings and visual observations show no seepage breakout on the downstream dam faces, no total heads above ground surface, and total heads in the dams that result in calculated static safety factors above 1.5 following the 1981 improvements to Harriman Dam.

New surveillance plots will be developed that depict "warning" values for each piezometer to aid in rapid evaluation.

No current surveying programs are deemed necessary at this time due to the absence of significant differential settlement.

7. STABILITY OF STRUCTURES

Extensive static and seismic stability analyses were conducted during 1980-81 for both of these structures. These studies were based on detailed field and laboratory testing, as well as visual observations. The results of these studies appear in the 1982 stability reports. All calculated stability factors remain above currently accepted minimum values.

8. SPILLWAY ADEQUACY

A. Harriman - Adequacy of the Harriman Dam "morning glory" spillway structure has been periodically evaluated by NEPCo. Based on these evaluations, the embankment crest was raised in 1939 and 1964 to insure that the project could safely pass updated project design floods. At the present time (1982), FERC, in conjunction with other Federal agencies, is conducting a full review of the project spillway to include PMP, unit hydrographs and spillway discharge characteristics. Further evaluation of spillway adequacy of the Harriman Dam "morning glory" spillway by the inspection team must await results of FERC's investigaions.

B. Sherman - Adequacy of the Sherman Dam spillway has been periodically evaluated by NEPCo. At the present time, further evaluation must await results of studies of the Harriman Dam spillway outflow hydrograph being conducted by FERC.

9. PRIOR REPORTS

Since the 1978 FERC report, there have been several reports concerning both Harriman and Sherman issued by MAIN and Geotechnical Engineers, Inc. (GEI) regarding field and laboratory testing, and static and seismic stability analyses of the project embankments. These reports have been previously referenced, and the writers of this document are thoroughly familiar with the contents of all prior reports.

10. CONCLUSIONS

Based on this inspection, the results of the studies reported herein, as well as the prior inspection reports and related stability investigations, MAIN concludes that no emergency remedial works are required at either Harriman or Sherman at this time. Specific comments follow.

A. Harriman Development - The dam (including intake and spillway) and powerhouse are in excellent condition, with evidence of good maintenance and operating procedures.

The stability berm added to the downstream slope (along with collector drains, weirs, etc.) has improved both drainage and stability characteristics, though grass surfacing and berm crest drainage maintenance remain to be completed.

The dam crest road remains in good condition, except for minor cracking (not related to structural causes). No problems were noted with upstream riprap, with the exception of excessive grass and brush growing in a few areas. The seep and swampy area at the right abutment has not changed, and studies reported elsewhere show that it poses no threat to the dam.

The powerhouse exhibited a generally good appearance. A small water seep at Unit 3 foundation drain and a few small concrete cracks (some with calcite coatings) were the only significant features observed.

The diversion tunnel and the morning glory spillway show several areas of spalling, but not structurally serious. The underground valve chamber and bypass valve are in excellent condition with new control piping and pipe supports. The brick intake house requires repointing, and the fractured rock face south of the spillway should be visually monitored as in the past.

B. Sherman Development - With only minor exceptions, the dam, intake and spillway are in excellent condition.

A slight deterioration of the surface of the crest road and some areas of brush and grass overgrowth on the upstream riprap are evident. The concrete cribwall and upstream concrete training walls below the penstock intake show cracking and deterioration that will need attention.

The flashboard system at the spillway is in good condition, but cracking and deterioration of the rock surface on the bridge over the spillway are in evidence.

The powerhouse itself shows no serious adverse conditions. Cracks and seeps in the foundation are minor and do not suggest large differential settlement. Some concrete deterioration appears at and below the waterline above the draft tube exit, though it is not serious and does not have structural consequences.

Seepage breakout does occur on the slope in the rear of the powerhouse and probably contributes to the slow, but continuing movements, of the low concrete retaining wall toward the powerhouse.

11. RECOMMENDATIONS

It is recommended that the next FERC five year inspection of Sherman and Harriman developments be conducted in 1988 in conjunction with the remaining Deerfield River developments forming FERC Project No. 2323. This will restore the continuity of the Project No. 2323 inspections.

Based on MAIN's evaluation of the results of the inspection of Harriman and Sherman developments, as well as the above stated conclusions, we make the following recommendations:

A. Harriman

1) Grading and grassing of new stability berm should be completed and maintained until grass is well established.

2) Regrade the drainage ditch on top of the new stability berm to provide gravity drainage.

3) Remove grass and brush from upstream riprap to improve visual inspection capability.

4) Continue to monitor new piezometers and weirs an an indication of performance.

5) Repair concrete spalling at the spillway.

6) Repoint brick intake building.

7) Closely examine potentially loose rock on slope south of intake and carefully remove or reinforce large blocks that could fall and damage the spillway foot bridge structure.

8) Schedule an internal inspection of the spillway discharge tunnel at a time in the future when the conduit is dry and prior to the next 5 year inspection.

B. Sherman

1) Remove grass and brush from upstream riprap to improve visual inspection capability.

2) Repair deteriorated concrete cribwall and upstream training wall at penstock intake.

3) Repair surface of spillway bridge.

4) Continue to monitor new piezometers.

5) Continue to monitor seep at left abutment, and slope movement and seepage behind the powerhouse.

6) Remove a section of grillage to permit interior inspection of the bypass tunnel prior to the next 5 year inspection.

FIGURES

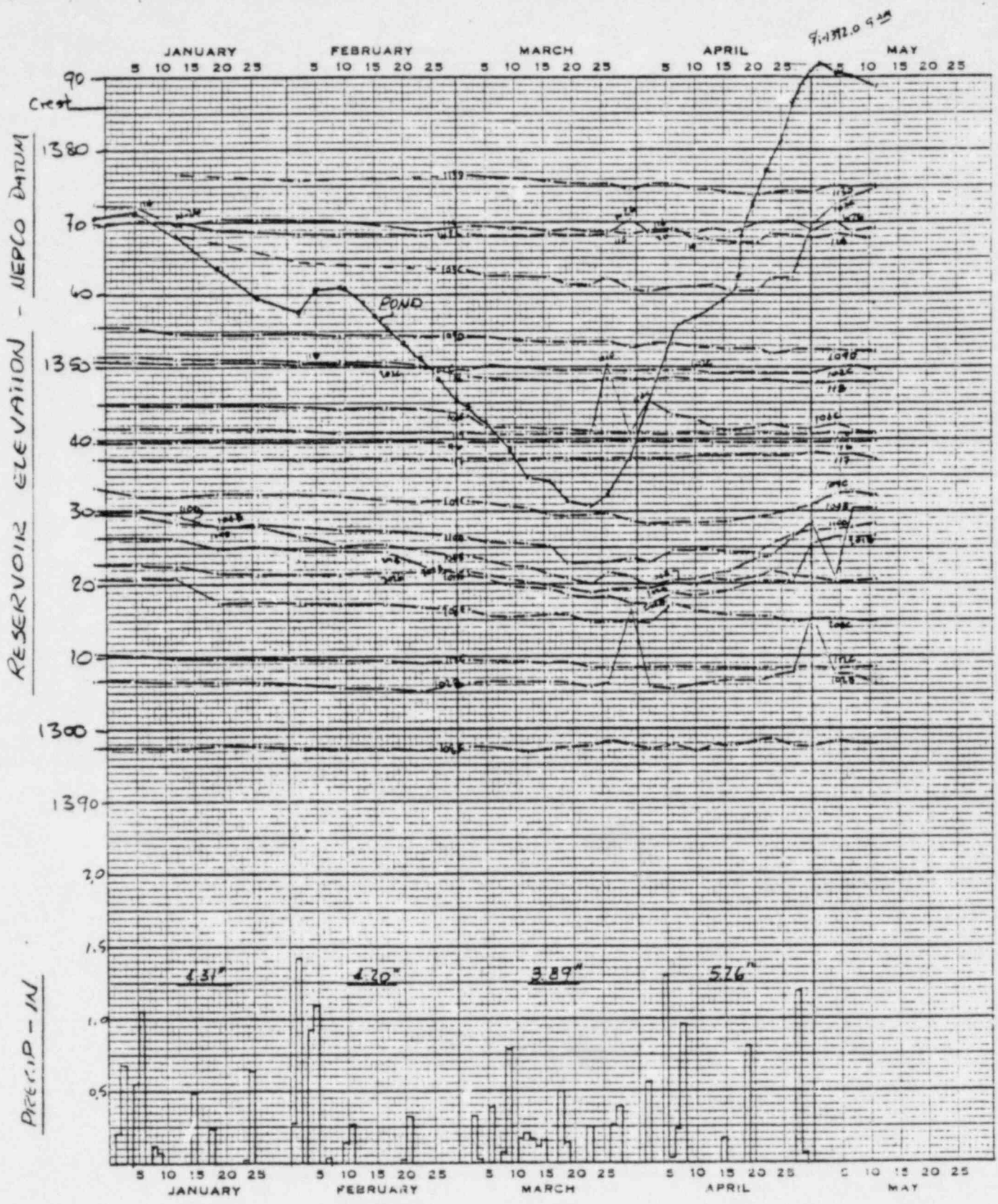
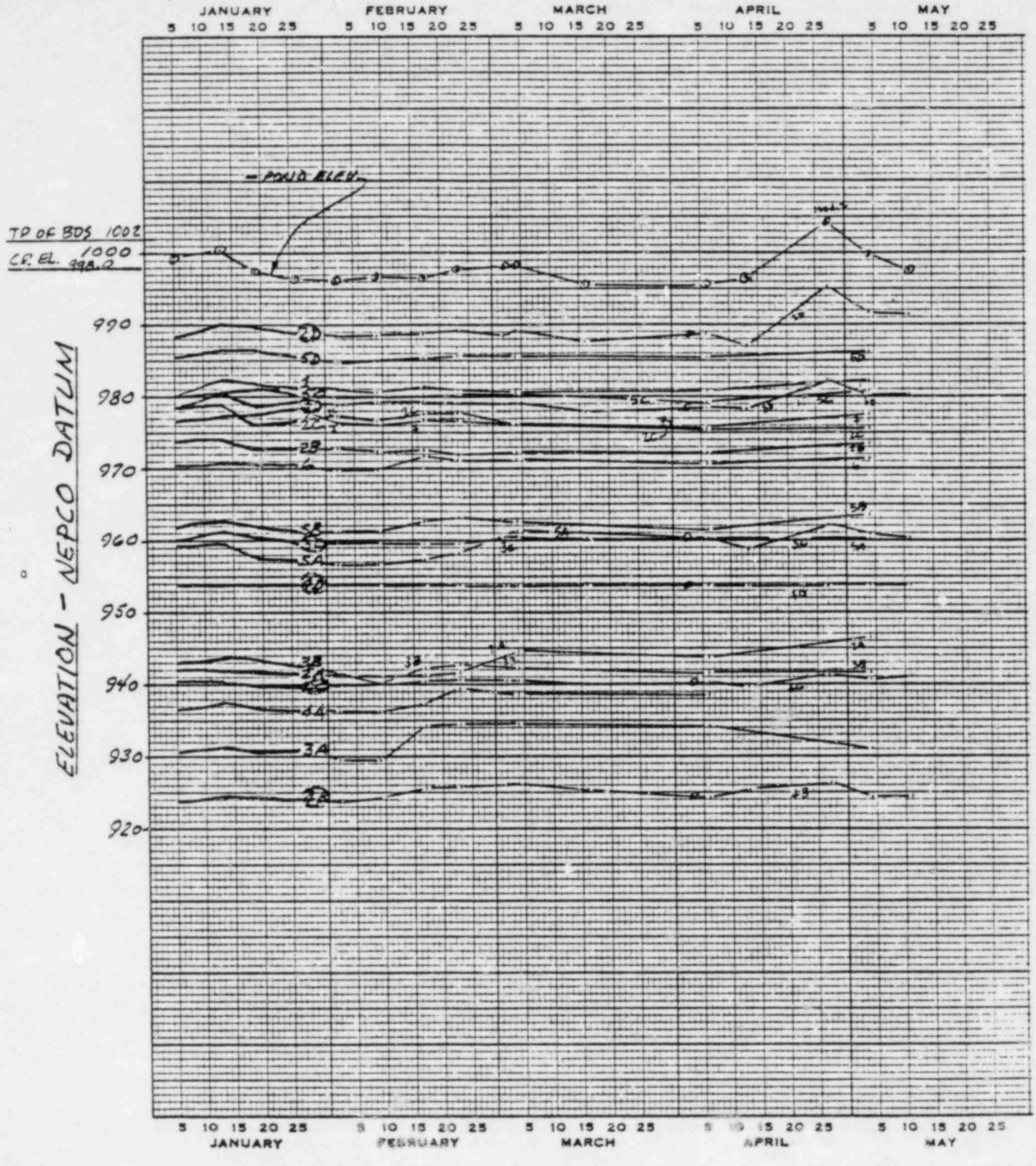


Figure 1
Critical Piezometer Plots
Harriman Dam - 1982

MAIN



O = Critical Piezometers.

Figure 2
Critical Piezometer Plots
Sherman Dam - 1982

MAIN

APPENDIX A

PHOTOS - HARRIMAN DAM

Photo No. 1
View Across Dam at Top of Berm
Note Minor Erosion and Ponded
Water, Sediment Collection at Toe
of Dam. 1981 Modification

Photo No. 2
View of Downstream Slope at Dam
Centerline. 1981 Modification.
Note Eroded Material and Cloudy Water
at Toe of Dam

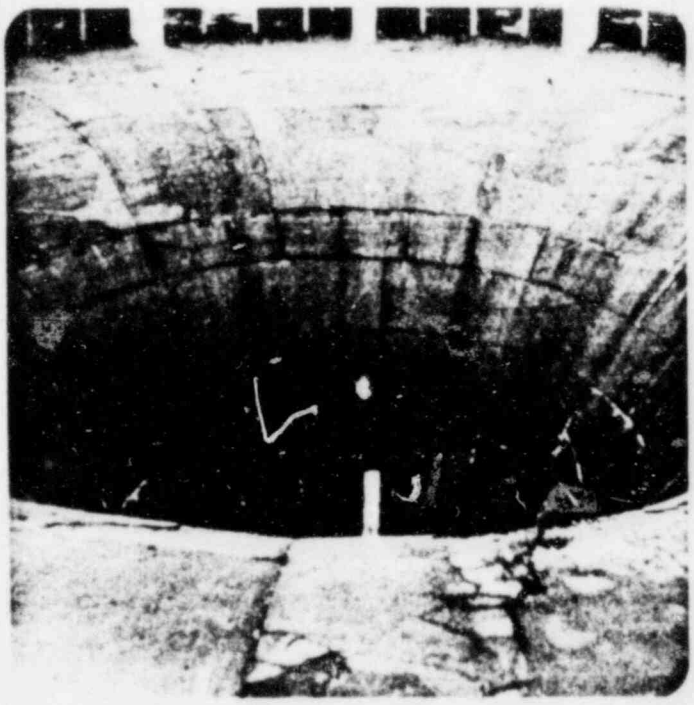


Photo No. 3
Interior of Glory Hole Spillway
Note Foundation/Concrete
Lining Drain Flow

Photo No. 4
Interior Slope of Glory Hole Spillway
Note Spalled Concrete

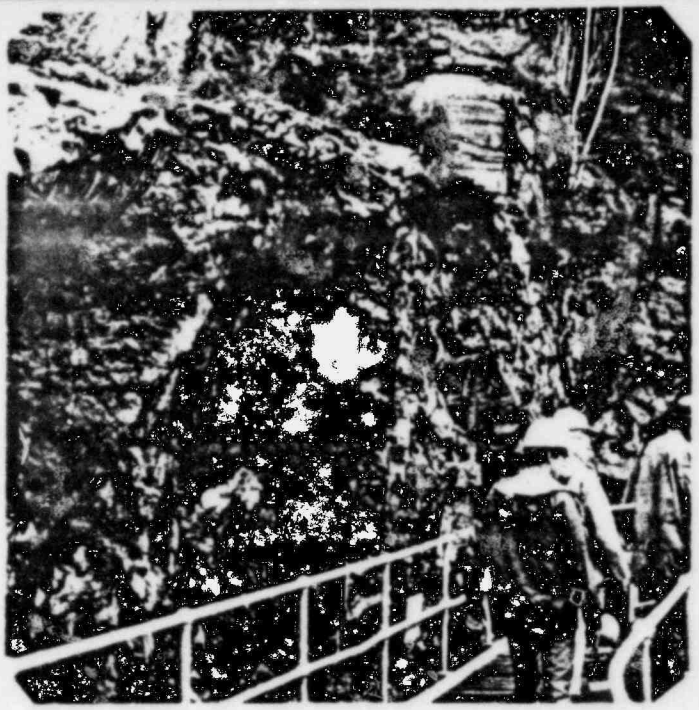


Photo No. 5
Fractured Rock Face at Intake
Note Overhang and Jointing

Photo No. 6
Retaining Wall Adjacent to Powerhouse
Note Cracking and Staining

Photo No. 7
Powerhouse Wall Above Draft Tubes
Note Seepage and Stains

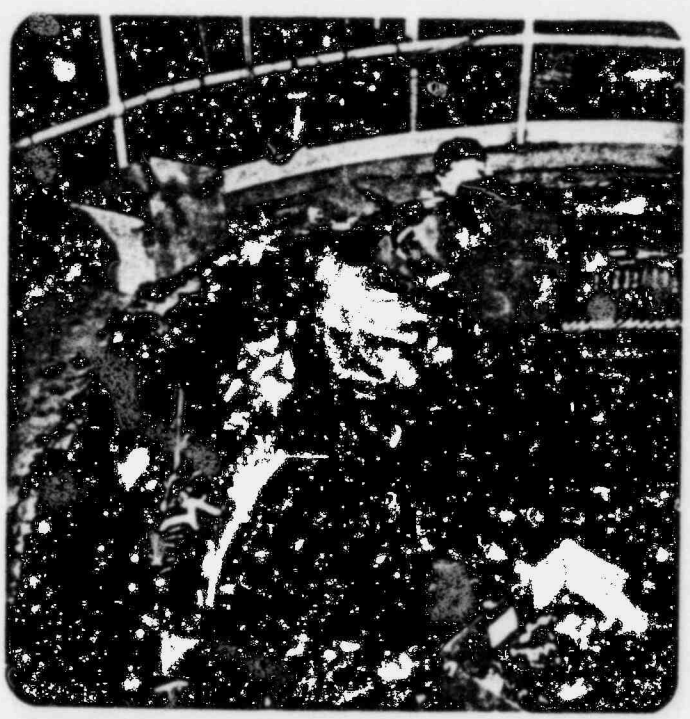


Photo No. 8
Unit 1 Generator Stator Under Repair

APPENDIX B

PHOTOS - SHERMAN DAM

Photo No. 1
Lower Spillway
Note Rock Jointing

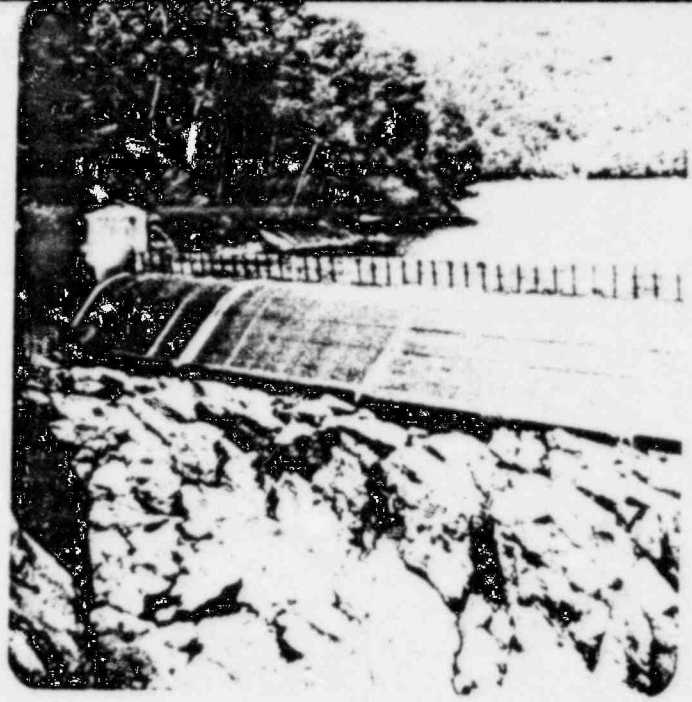


Photo No. 2
Upper Spillway
Note Wood Flashboards, Minor Concrete Spalling and Rock Jointing

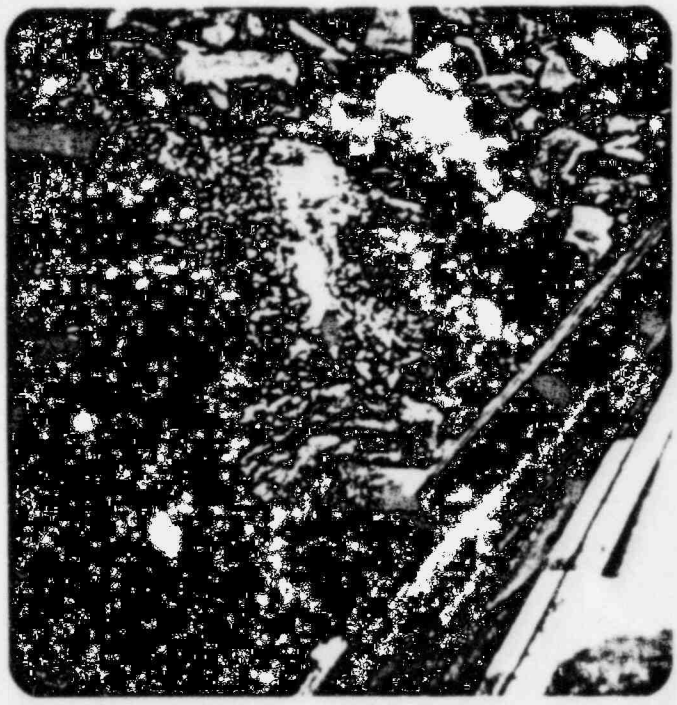


Photo No. 3
Intake Structure
Note Deteriorated Concrete on Submerged Training Wall

Photo No. 4
Concrete Crib Wall
Upslope of Intake
Valve Chamber

Photo No. 5
Downstream End of Diversion Tunnel
Note Deteriorated Concrete, Debris

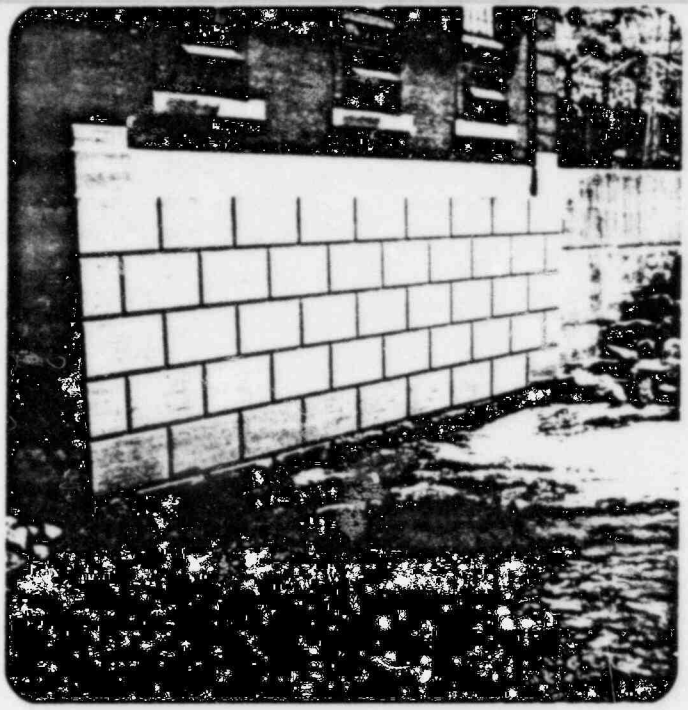


Photo No. 6
Face of Powerhouse Over Draft Tubes
Note Deteriorated Concrete at Water Line

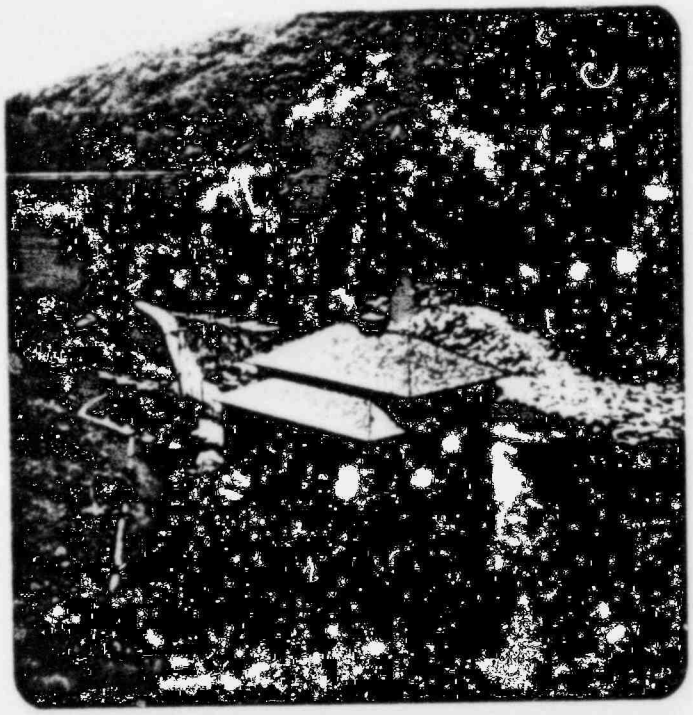


Photo No. 7
View of Powerhouse and Transformers from Dam Crest

Photo No. 8
View of Retaining Wall Behind Powerhouse
Note Tilt and Deformation