CONNECTICUT RIVER BASIN
BETHLEHEM NEW HAMPSHIRE

BETHLEHEM DAM
N.H.00279

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

APRIL, 1979

DISTRIBUTION STATEMENT A
Approved for public release
Distribution Unlimited

85 6 18 197
DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.
Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Dear Governor Gallen:

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

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, Dr. Arnold Polonsky, Bethlehem, New Hampshire 03574.

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

I wish to take this opportunity to thank you and the Water Resources Board for your cooperation in carrying out this program.

Sincerely,

[Signature]

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer
**Bethlehem Dam Inspection Report**

**NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS**

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

The dam is a run of the river dam with a concrete spillway and earth embankments with concrete core wall at the abutments. The overall length of the dam is 282 ft. and it has a maximum height of 29 ft. It is small in size with a low hazard potential classification. The dam was judged to be in fair condition. The owner should implement a program of annual periodic technical inspection and maintenance.
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
Identification No: NH00279
Name of Dam: Bethlehem Dam
Town: Bethlehem
County and State: Grafton County, New Hampshire
Stream: Lower Ammonoosuc River
Date of Inspection: November 14, 1978

BRIEF ASSESSMENT

The Bethlehem Dam is a run-of-the-river dam with a concrete spillway and earth embankments with concrete core wall at the abutments. The overall length of the dam is 282 feet and it has a maximum height of 29 feet. The dam is no longer serving its original purpose, but the current owner is investigating restoring the dam for hydroelectric power. The drainage area is 96.1 square miles and the normal impoundment surface area is approximately 5.5 acres.

Based on a size classification of small and a hazard classification of low, in accordance with "Recommended Guidelines for Safety Inspection of Dams, Department of the Army, November 1976" the test flood for this dam is the 100-year return flood. Because of the limited storage the test flood outflow is equal to the test flood inflow. The test flood of 16,890 CFS overtops the spillway wingwalls and abutments by 0.4 feet. The spillway has a capacity without overtopping of 91.7 percent of the test flood.

The dam is judged to be in fair condition. The following significant conditions were observed:

1. Significant erosion and deterioration were observed at the earth embankments and core walls at both abutments.

2. Extensive siltation was found inside the hollow compartments of the spillway, restricting the operation of the base slab drains.

3. The condition of the gate house constitutes a dangerous environment to trespassers.

A detailed assessment and recommendations for remedial measures are contained in Section 7. In summary, it is recommended that the following actions be taken under the guidance of a qualified engineer within one year of the receipt of this report:

1. Repair the core walls and replace embankment material to original grades.
2. Remove the silt from the interior compartments and determine its origin.

3. Repair or replace the waste gate.

In addition, the owner should implement a program of annual periodic technical inspection and maintenance including the following items:

1. Remove trees from earth embankments.
2. Prevent access to the gate house.
3. Maintain gates in operable condition.
4. Repair and patch cracked and spalled concrete.
This Phase I Inspection Report on Bethlehem Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

JOSEPH A. McELROY, MEMBER
Foundation & Materials Branch
Engineering Division

CARNEY TERZIAN, CHAIRMAN
Chief, Structural Section
Design Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division
This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Letter of Transmittal</td>
<td></td>
</tr>
<tr>
<td>Brief Assessment</td>
<td></td>
</tr>
<tr>
<td>Review Board Page</td>
<td></td>
</tr>
<tr>
<td>Preface</td>
<td>i</td>
</tr>
<tr>
<td>Table of Contents</td>
<td>ii-iv</td>
</tr>
<tr>
<td>Overview Photo</td>
<td>v</td>
</tr>
<tr>
<td>Location Map</td>
<td>vi</td>
</tr>
</tbody>
</table>

## REPORT

### 1. PROJECT INFORMATION

1.1 General  
   
   a. Authority  
   b. Purpose  

1.2 Description of Project  
   
   a. Location  
   b. Description of Dam and Appurtenances  
   c. Size Classification  
   d. Hazard Classification  
   e. Ownership  
   f. Operator  
   g. Purpose  
   h. Design and Construction History  
   i. Normal Operational Procedures  

1.3 Pertinent Data  
   
   a. Drainage Area  
   b. Discharge at Dam Site  
   c. Elevations  
   d. Reservoir  
   e. Storage  
   f. Reservoir Surface  
   g. Dam  
   h. Diversion and Regulating Tunnel  
   i. Spillway  
   j. Regulating Outlets  

ii
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. ENGINEERING DATA</td>
<td></td>
</tr>
<tr>
<td>2.1 Design</td>
<td>2-1</td>
</tr>
<tr>
<td>2.2 Construction</td>
<td>2-1</td>
</tr>
<tr>
<td>2.3 Operation</td>
<td>2-1</td>
</tr>
<tr>
<td>2.4 Evaluation</td>
<td></td>
</tr>
<tr>
<td>a. Availability</td>
<td>2-1</td>
</tr>
<tr>
<td>b. Adequacy</td>
<td>2-1</td>
</tr>
<tr>
<td>c. Validity</td>
<td>2-2</td>
</tr>
<tr>
<td>3. VISUAL INSPECTION</td>
<td></td>
</tr>
<tr>
<td>3.1 Findings</td>
<td>3-1</td>
</tr>
<tr>
<td>a. General</td>
<td>3-1</td>
</tr>
<tr>
<td>b. Dam/Spillway</td>
<td>3-1</td>
</tr>
<tr>
<td>c. Appurtenant Structures</td>
<td>3-2</td>
</tr>
<tr>
<td>d. Reservoir Area</td>
<td>3-3</td>
</tr>
<tr>
<td>e. Downstream Channel</td>
<td>3-3</td>
</tr>
<tr>
<td>3.2 Evaluation</td>
<td>3-3</td>
</tr>
<tr>
<td>4. OPERATIONAL PROCEDURES</td>
<td></td>
</tr>
<tr>
<td>4.1 Procedures</td>
<td>4-1</td>
</tr>
<tr>
<td>4.2 Maintenance of Dam</td>
<td>4-1</td>
</tr>
<tr>
<td>4.3 Maintenance of Operating Facilities</td>
<td>4-1</td>
</tr>
<tr>
<td>4.4 Description of Warning System</td>
<td>4-1</td>
</tr>
<tr>
<td>4.5 Evaluation</td>
<td>4-1</td>
</tr>
<tr>
<td>5. HYDRAULIC/HYDROLOGIC</td>
<td></td>
</tr>
<tr>
<td>5.1 Evaluation of Features</td>
<td>5-1</td>
</tr>
<tr>
<td>a. General</td>
<td>5-1</td>
</tr>
<tr>
<td>b. Design Data</td>
<td>5-1</td>
</tr>
<tr>
<td>c. Experience Data</td>
<td>5-1</td>
</tr>
<tr>
<td>d. Visual Observation</td>
<td>5-1</td>
</tr>
<tr>
<td>e. Test Flood Analysis</td>
<td>5-1</td>
</tr>
<tr>
<td>f. Dam Failure Analysis</td>
<td>5-2</td>
</tr>
<tr>
<td>6. STRUCTURAL STABILITY</td>
<td></td>
</tr>
<tr>
<td>6.1 Evaluation of Structural Stability</td>
<td>6-1</td>
</tr>
<tr>
<td>a. Visual Observation</td>
<td>6-1</td>
</tr>
<tr>
<td>b. Design and Construction Drawings</td>
<td>6-1</td>
</tr>
<tr>
<td>c. Operating Records</td>
<td>6-1</td>
</tr>
<tr>
<td>d. Post-Construction Changes</td>
<td>6-1</td>
</tr>
<tr>
<td>e. Seismic Stability</td>
<td>6-1</td>
</tr>
</tbody>
</table>
### 7. ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1 Dam Assessment</td>
<td>7-1</td>
</tr>
<tr>
<td>a. Condition</td>
<td>7-1</td>
</tr>
<tr>
<td>b. Adequacy of Information</td>
<td>7-1</td>
</tr>
<tr>
<td>c. Urgency</td>
<td>7-1</td>
</tr>
<tr>
<td>d. Need for Additional Investigation</td>
<td>7-1</td>
</tr>
<tr>
<td>7.2 Recommendations</td>
<td>7-2</td>
</tr>
<tr>
<td>7.3 Remedial Measures</td>
<td>7-2</td>
</tr>
<tr>
<td>a. Operation and Maintenance Procedures</td>
<td>7-2</td>
</tr>
</tbody>
</table>

### APPENDICES

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>APPENDIX A - VISUAL INSPECTION CHECK LIST</td>
<td>A-1</td>
</tr>
<tr>
<td>APPENDIX B - PROJECT RECORDS AND PLANS</td>
<td>B-1</td>
</tr>
<tr>
<td>APPENDIX C - PHOTOGRAPHS</td>
<td>C-1</td>
</tr>
<tr>
<td>APPENDIX D - HYDROLOGIC AND HYDRAULIC COMPUTATIONS</td>
<td>D-1</td>
</tr>
<tr>
<td>APPENDIX E - INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS</td>
<td>E-1</td>
</tr>
</tbody>
</table>
OVERVIEW OF
BETHLEHEM DAM
BETHLEHEM, NEW HAMPSHIRE
1.1 General

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Dufresne-Henry Engineering Corporation has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to Dufresne-Henry Engineering Corporation under a letter of November 20, 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0010 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) Perform technical inspection and evaluation of non-federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by nonfederal interests.

(2) Encourage and prepare the states to initiate quickly effective dam safety programs for nonfederal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location

The Bethlehem Dam is located in northern New Hampshire, in the Town of Bethlehem, Grafton County. The dam is on the Lower Ammonoosuc River which is in the Connecticut River Basin.

b. Description of Dam and Appurtenances

The Bethlehem Dam has an overall length of 282 feet and a maximum height of 29 feet. The main components of the dam include a reinforced concrete spillway and earth embankments with concrete core walls at each abutment.
The dam is 29 feet high and was originally constructed for the generation of power. Water impounded by the dam was piped through a 72-inch steel penstock to a power house located approximately 1000 feet downstream where the available head is 45 feet.

The gate works, located on the right river bank include a penstock head gate and a waste gate.

The dam was originally equipped with 4-foot flashboards. The 4-inch diameter pipe support inserts are visible across the dam crest, but there is no evidence of the boards or vertical supports.

c. **Size Classification**

The Bethlehem Dam has a maximum height of 29 feet and an estimated maximum storage of 116 acre-feet. In accordance with the guidelines, dams with maximum storage between 50 and 1000 acre-feet and/or maximum height between 25 and 40 feet are sized as small. Therefore the Bethlehem Dam is classified as small.

d. **Hazard Classification**

A failure of the Bethlehem Dam would route a flood wave into the lower river channel. Because of the relatively small storage volume and natural channel constriction immediately downstream of the dam, any flood wave produced would easily be contained within the river banks. Therefore, the hazard classification of the Bethlehem Dam is low.

e. **Ownership**

The present owner of the Bethlehem Dam is:

Dr. Arnold Polonsky  
Bethlehem  
New Hampshire  03574

The previous owner was the Public Service Company of New Hampshire.

f. **Operator**

At the present time there is no regular operation or maintenance being performed on the dam. The responsibility for operation of the dam lies with the owner, Dr. Arnold Polonsky, telephone 603-444-2453.
g. **Purpose**

The Bethlehem Dam is no longer serving its original purpose. A study by the owner is currently under way investigating the possibility of restoring the dam for private power generation.

h. **Design and Construction History**

The present reinforced concrete dam is an Ambursen type dam, built by the Ambursen Construction Company in 1926. The dam was a replacement for an earlier log crib dam which impounded water for a hydroelectric power house located 1000 feet downstream.

The spillway section is composed of nine hollow chambers, accessible from both concrete abutments. A catwalk located 5 feet above the chamber floors runs the entire length of the spillway to allow inspection of the interior. The chambers are drained by small openings located at the toe of the spillway. A concrete energy dissipator forms an integral part of the concrete spillway and has been effective in preventing washout of the downstream foundation material. The plans found in Appendix B have been drawn from visual observation and data on file with the New Hampshire Water Resources Board including design drawings.

The dam has not undergone any significant structural change since the original construction.

i. **Normal Operational Procedure**

The dam is not being operated at the present time. The waste gate is inoperable in the closed position.

1.3 **Pertinent Data**

a. **Drainage Area**

The drainage basin of the Bethlehem Dam encompasses approximately 96 square miles of variable terrain from rolling hills along Routes 3 and 302 to the mountainous terrain of the White Mountain National Forest.

The predominant soils are glacial till with hardpan or bedrock within three feet of the surface.

b. **Discharge at Dam Site**

At the present time the discharge at the site includes only the overflow spillway. A penstock head gate and waste gate...
are inoperable and in the closed position. No records nor recollections of any flooding could be found for this dam site.

Spillway capacity at top of dam - 15,480 CFS.

c. Elevations

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Streambed at Centerline of Dam</td>
</tr>
<tr>
<td></td>
<td>1115.</td>
</tr>
<tr>
<td>2</td>
<td>Maximum Tailwater</td>
</tr>
<tr>
<td></td>
<td>Variable.</td>
</tr>
<tr>
<td>3</td>
<td>Upstream Portal Invert</td>
</tr>
<tr>
<td></td>
<td>Not applicable.</td>
</tr>
<tr>
<td>4</td>
<td>Recreation Pool</td>
</tr>
<tr>
<td></td>
<td>1135 +.</td>
</tr>
<tr>
<td>5</td>
<td>Full Flood Control Pool</td>
</tr>
<tr>
<td></td>
<td>Not applicable.</td>
</tr>
<tr>
<td>6</td>
<td>Spillway Crest</td>
</tr>
<tr>
<td></td>
<td>1134.6.</td>
</tr>
<tr>
<td>7</td>
<td>Design Surcharge</td>
</tr>
<tr>
<td></td>
<td>1143.6.</td>
</tr>
<tr>
<td>8</td>
<td>Top of Dam</td>
</tr>
<tr>
<td></td>
<td>1143.6</td>
</tr>
<tr>
<td>9</td>
<td>Test Flood Elevation</td>
</tr>
<tr>
<td></td>
<td>1144</td>
</tr>
</tbody>
</table>

**Reservoir**

<table>
<thead>
<tr>
<th></th>
<th>Feet*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Maximum Pool</td>
<td>2800</td>
</tr>
</tbody>
</table>

*Estimated based on aerial photographs, USGS maps and estimated average water depths.
Length of Recreation Pool: 1700
Length of Flood Control Pool: Not applicable.

**e. Storage**

<table>
<thead>
<tr>
<th>Pool</th>
<th>Acre-Feet *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recreation Pool</td>
<td>22</td>
</tr>
<tr>
<td>Flood Control Pool</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Test Flood Pool</td>
<td>116</td>
</tr>
<tr>
<td>Spillway Crest Pool</td>
<td>22</td>
</tr>
<tr>
<td>Top of Dam</td>
<td>116</td>
</tr>
</tbody>
</table>

**f. Reservoir Surface**

<table>
<thead>
<tr>
<th>Location</th>
<th>Acres *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Dam</td>
<td>9</td>
</tr>
<tr>
<td>Test Flood Pool</td>
<td>9</td>
</tr>
<tr>
<td>Flood-Control Pool</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Recreation Pool</td>
<td>5.5</td>
</tr>
<tr>
<td>Spillway Crest</td>
<td>5.5</td>
</tr>
</tbody>
</table>

**g. Dam**

1. **Type**

Run-of-river dam consisting of earth embankments with concrete core walls adjoining a 140-foot Ambursen concrete spillway.

2. **Length**

282 feet overall; 140 feet spillway.

3. **Height**

20 feet (concrete spillway; 29 feet (top of training walls)).

4. **Top Width**

Earth embankments eroded below top of core wall.

5. **Side Slopes**

- Earth Embankments - Upstream 2:1
- Downstream 2:1
- Concrete Spillway - Upstream 1:1
- Downstream - variable

* Estimated based on aerial photographs, USGS maps and estimated average water depths.

1-5
(6) **Zoning**

None known.

(7) **Impervious Core**

Concrete core wall.

(8) **Cutoff**

Concrete footing.

(9) **Grout Curtain**

None known.

h. **Diversion and Regulating Tunnel**

Not applicable.

i. **Spillway**

The spillway is a concrete Ambursen type spillway containing nine hollow compartments. The spillway is 140 feet long and 20 feet high from the streambed to the overflow crest. An energy dissipating apron is located at the toe of the spillway.

j. **Regulating Outlets**

The gate works located at the right abutment contain a headgate for the trash rack and penstock to the old power house and a waste gate. Both gates are in the closed position and are inoperable due to rotting vertical members and lack of any mechanical lifting devices. The penstock head gate is 7 feet wide by 19.5 feet deep with an invert elevation of 89.5. The waste gate is 8 feet wide by 19.5 feet deep also with an invert elevation of 89.5.
SECTION 2 - ENGINEERING DATA

2.1 Design

Complete construction drawings were available for review during the investigation. The concrete spillway is an Ambursen design and consists of 9 hollow compartments, each 15'-6" in length. The interior of the dam contains a walkway located five feet above the floor slab. Each compartment contains base slab drains to relieve hydrostatic pressures and reduce uplift forces. Any water entering these drains flows out of the compartments via additional drains located at the base of the spillway (see cross-section on Plans).

2.2 Construction

Record data on file with the New Hampshire Water Resources Board includes several entries of correspondence and inspections during the construction of the dam. There was no data included which would affect the present safety of the dam.

The dam was completed in February 1926 and used 3855 cubic yards of concrete.

2.3 Operation

The dam is not being operated at the present time. Certain design features of the dam, namely the base slab drainage systems, were designed to operate without manual procedures. The operation of this drainage system is severely restricted by the excessive amount of sediment buildup within the spillway compartments. Without the drainage system, uplift forces may develop which might affect the stability of the structure. The origin of the sediment is also cause for concern. If the material is coming from the foundation soils, a serious condition may exist with the creation of voids, further reducing the dam's stability.

2.4 Evaluation

a. Availability

Construction drawings were available for review during the investigation.

b. Adequacy

The information obtained from the construction drawings and the visual observations are adequate to conclude that a potential problem exists. The problem cannot be verified
until the sediment is removed from the compartments, the operational status of the drains determined and the origin of the sediment established.

c. **Validity**

Not applicable.
3.1 Findings

a. General

The on-site inspection of the Bethlehem Dam was performed on November 14, 1978. Weather conditions were cloudy with the temperature in the mid-40s. Water was flowing over the spillway section of the dam, somewhat hampering the visual observation of the dam. No emergency conditions were observed on the day of inspection.

b. Dam/Spillway

The concrete spillway was found to be in generally good condition based on a limited visual inspection. The downstream face of the spillway shows some signs of erosion, especially at the construction joints between the compartment sections (see Photos 2 and 11).

A dark area can be seen on the downstream face of the first compartment from the right just below the crest (see Photo 5). This area indicates a smoother surface and may be a repair patch applied in the past. Anchor bolts and plates found in the interior of the first compartment support this assumption.

As described in Section 1.2.h, the concrete spillway consists of nine hollow compartments. The compartments are connected by a passageway and walkway. This design feature offered a unique opportunity to inspect the dam from its interior. The interior of the dam appeared to be in good condition with the exception of the far righthand compartment, where the concrete is extensively spalled in several locations, exposing the reinforcing steel (see Photo 4).

Photo 4 also shows two anchor plates and bolts which appear to be anchoring something on the downstream face of the dam. Photo 5 shows the downstream face of the compartment with a dark area located where the interior anchor plates were observed. It appears that the concrete in this area has a smoother texture and may be newer than the adjacent concrete. This could not be confirmed during the inspection because of the amount of water flowing over the dam.

During the inspection of the interior compartments, a considerable amount of fine sediment, up to 5 feet thick, was found in each compartment. The surface of the sediment slopes downstream. The origin of the sediment could not be determined during the initial visual inspection. Section 6
will discuss the sediment in more detail and assess possible structural implications.

c. **Appurtenant Structures**

1. **Core Walls**

   The right side core wall extends from the gate works into the right river bank. The wall is exposed for approximately 20 feet adjacent to the gate works. Earth embankment material has eroded and the core wall is spalling (see Photo 7).

   The left core wall extends from the left wingwall into the left river bank and is exposed and badly spalled in several areas. It appears that the embankment material has been washed away leaving the core wall exposed to erosion and spalling. The remaining embankment is covered with trees and small brush (see Photo 8).

2. **Gate Works**

   The gate works, located at the right side of the spillway contain one head gate for the penstock and one waste gate. These gates are in the closed position and all lifting mechanisms have been removed. The vertical wooden members which contain the "rack" gear trains are rotting and could not be used to lift the gates.

   Photo 6 shows the downstream side of the gate works and the sluiceway for the waste gate. A large leak can be seen at the lower left hand corner of the waste gate. The leak is occurring around the gate through spalled and eroded concrete.

   The structural concrete of the building and training walls is in fair to poor condition. Extensive spalling is occurring on the training walls (see Photo 6) and the upstream faces of the foundation. The structural concrete of the superstructure is in good condition (see Photo 7).

   All mechanical equipment plus doors, windows, railings, etc. have been removed from the building. This leaves the site open to trespassing and further damage from vandals. The inside of the building constitutes a dangerous environment because of the missing guard railings. Deep pits and channels are exposed and severe injury or loss of life could result if someone should fall into one.
d. **Reservoir Area**

The reservoir area is a wide section of the natural river channel (see Photos 10 and 12). The most significant aspect of the reservoir area is the amount of sediment in the impoundment pool. Normal water depths at the dam vary from 2 to 5 feet deep. This sedimentation has greatly reduced the storage volume of the reservoir.

e. **Downstream Channel**

Photo 9 shows a typical section of the downstream channel which is the natural river bed of the Ammonoosuc River. The river bends to the left just downstream of the dam and narrows considerably. Ice jamming occurs during the spring runoff in this area. Damage to trees on both banks indicates that the ice jamming is very extensive and often approaches the height of the dam.

3.2 **Evaluation**

The visual inspection did not disclose any immediate problems. The following findings, however, indicate areas of concern which may develop into problems in the near future:

a. The concrete in the far right hand compartment is showing signs of deterioration and has apparently been repaired at least once in the past.

b. The earth embankments at both abutments have been partially eroded away, exposing the concrete core walls which have undergone extensive deterioration.

c. The siltation inside the spillway compartment can impair the drainage of the foundation soils under the dam. According to the design drawings, drainage is intended through drain holes in the base of the dam with the purpose of reducing uplift pressures. Possible sources of the silt are:

1. Inflow of water with silt through the vent and drains in the downstream apron at times when a sufficiently high tailwater may have developed as a result of ice jams downstream of the dam.

2. Leakage of silty water through cracks in the upstream wall (deck) of the dam.

3. Silty water coming through the foundation drains.
If the third mechanism were responsible for even a small fraction of the silt observed, it would indicate a very serious condition of development of voids in the foundation soils under the dam.

d. The gate works building has been vandalized and trespassing is extensive. The potential for accidental injury is high due to missing guard rails, broken glass and easy access.
SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures
None.

4.2 Maintenance of Dam
None.

4.3 Maintenance of Operating Facilities
None.

4.4 Description of Warning System
None.

4.5 Evaluation

The failure to remove the silt from the dam's interior compartments may have rendered the dam's underdrain system inoperable. This could lead to serious problems in the future. Under emergency conditions, it would be helpful if at least one of the gates were operational. The waste gate should either be made operational or replaced with a stop log sluiceway which could be removed more easily in the event of an emergency.

The safety of the gate works building should be improved by securing the building against trespassing. Windows should be replaced or bricked up and metal doors installed.
SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. General

The Bethlehem Dam has a concrete Ambursen type spillway, originally designed with four-foot flashboards, which have since been eliminated. The gate works contain two gates which are inoperable and cannot be used in determining hydraulic capacities.

b. Design Data

The original hydraulic and hydrologic design criteria were not available for this project.

c. Experience Data

The U. S. Geological Survey, in its summary paper of the 1927 flood, gives a flood flow of 17,900 CFS at the Bethlehem Dam. This flow would have overtopped the abutments by approximately 0.5 feet. A similar report on the 1936 storm lists maximum discharge and tailwater elevations based on water marks. Using a reported crest elevation of 1134.6 and the stage discharge diagram found in Appendix D, the 1936 storm was approximately 13,100 CFS at a stage height of 8.1 feet, which would not have overtopped the dam.

In 1939 a river gauge was installed at Bethlehem Junction located approximately 1.5 miles upstream of the Bethlehem Dam. The maximum flow recorded at that gauge was 10,800 CFS on October 24, 1959. Transferring this flow to the Bethlehem Dam by the six tenths ratio of their drainage area would result in a flow of 11,800 or a stage discharge of 7.8 feet.

d. Visual Observation

The reservoir has undergone extensive sedimentation since its construction. In particular, the south side of the reservoir is very shallow, averaging only 2 feet deep under normal conditions. At one location the sediment has exceeded the water level and a small island has been formed (see Overview Photo).

e. Test Flood Analysis

The dam is classified to be small with a low hazard rating. In accordance with the Guidelines, a 100-year recurrence flood was selected as the test flood for this study.
Record flow data was analyzed for USGS Gauge 01137500 located in Bethlehem Junction, approximately 1-1/2 miles upstream of the Bethlehem Dam. The record flow data was processed by computer in accordance with the "United States Water Resources Guidelines" (Bulletin 17). The results of the Bethlehem Junction gauge analysis were adjusted to the dam site by the ratio of their drainage areas to the six tenths power. This has resulted in a 100-year test flood at the dam of 16,890 CFS.

The spillway capacity of 15,480 CFS is 91.7 percent of the test flood. The test flood would result in the overtopping of the abutments of 0.40 feet.

f. Dam Failure Analysis

A failure of the Bethlehem Dam under normal flow conditions would produce an initial flood surge of 8,420 CFS. Because of the limited normal storage volume, the initial surge would quickly subside. Using the general rule of two-thirds the height of the dam, an initial flood wave of 13.2 feet would be produced, which would be contained within the 15-20 foot river banks.

Under flood conditions with the water elevation at the top of the abutments, the flow over the dam would be 12,700 CFS. A failure of the spillway would produce a breach of approximately 56 feet and an overall flow increase of 8,640 CFS. Because of the run-of-the-river characteristics and low storage, the breach surge would quickly subside.

Photo 12, the overhead photo and the location map indicate that downstream geometry would dampen any flood wave produced by a dam failure. Photo 12 shows that a channel constriction downstream of the dam would reduce a flood wave, in addition to creating a backwater effect on the dam. This was confirmed by eyewitnesses who have observed the dam under high flow conditions. The exact depth of the backwater could not be determined. Approximately 2000 feet downstream of the dam the river makes a sharp right hand bend. The combination of channel constriction and directional change would significantly reduce the flood wave energy (velocity). This reduction in energy may result in some overbank flow in a remote unpopulated area at the bend. The nearest dwellings are located 4,000 feet downstream and approximately 20 feet above the river bed. Any flood wave produced by a dam failure would be of minimal effect by the time it reached this location.
SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observation

The visual inspection did not disclose any immediate stability problems. However, the presence of the unusually large volume of silt inside the spillway compartments is cause for concern and additional investigation.

b. Design and Construction Drawings

The design drawings indicate that drainage holes connected to longitudinal drains under the slab were installed through the base slab of the hollow concrete gravity overflow section. Drawing 2525 of 7-28-1925 shows details of the underdrain system. The purpose of such drainage holes is to reduce the uplift water pressures. The effectiveness of the drains may be impaired by the accumulation of silt on the base slab. If the drains are not functioning as intended, the potential development of uplift pressures would severely decrease the degree of stability of the dam against sliding.

The origin of the silt buildup is also a potential stability problem. If the silt or a portion of the silt is coming from the base slab drains, voids could be forming under the dam. The voids would also decrease the stability of the dam to resist sliding.

c. Operating Records

There are no operating records available that are significant with respect to the stability of the dam.

d. Post-Construction Changes

There are no known post-construction changes affecting the stability of the dam.

e. Seismic Stability

The dam is located in Seismic Zone 2 and in accordance with USCE Recommended Phase I Guidelines does not warrant seismic analysis.
SECTION 7 - ASSESSMENT, RECOMMENDATIONS/ REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition

The visual inspection indicated the dam to be in fair condition. However, as recommended in Section 7.2 the overflow section should be examined without water flowing over it.

There are no indications of problems affecting the immediate safety of the dam; however, the following features could adversely affect the safety in the future.

(1) Deterioration of the earth embankments at both abutments, particularly at the left abutment where a portion of the earth, downstream of the core wall, has washed away and the exposed core wall has spalled severely.

(2) The siltation of the spillway compartments is of concern for two reasons:

(a) The siltation is probably restricting the performance of the base slab drains.

(b) The origin of the silt needs to be investigated to determine whether it comes from the foundation soils.

b. Adequacy of Information

The visual inspection was limited because of the water flowing over the spillway. However, the data obtained during the inspection and the review of the plans provides adequate justification for the assessment and recommendations found in Section 7.2.

c. Urgency

The recommendations given in Section 7.2 should be carried out within one year after receipt of this report.

d. Need for Additional Investigations

There is no need for additional investigations beyond those recommended in Section 7.2.
7.2 Recommendations

The following items should be performed under the guidance of a qualified engineer:

1. An additional visual inspection of the dam should be performed after lowering the water level upstream of the dam by opening the waste gate so that no water flows over the spillway. The spillway should then be inspected with attention to the condition of the concrete of the overflow section and to the foundation soils at the toe of the dam for indications of undermining and seepage.

2. The silt should be removed from the interior compartments and the base slab drains cleared of all obstructions. After removal of the silt from the interior compartments, a qualified engineer should investigate the origin of the silt and determine if any undermining of the dam has occurred.

3. Repair both core walls, removing and patching spalled areas and replacing the embankment material.

4. Repair or replace the waste gate.

7.3 Remedial Measures

a. Operating and Maintenance Procedures

1. Trees growing on the downstream slopes of the embankment should be removed, the eroded portion of the slope rebuilt to grade and a suitable grass or stone cover established to prevent future erosion.

2. Access to the gate house should be prevented to reduce the risk of accidents to trespassers.

3. A periodic annual technical inspection and maintenance program should be instituted that includes operation of the gates and inspection of the dam when there is no flow over the spillway. Routine maintenance should include cleaning and patching of spalled concrete and sealing of construction jointing with asphalt or epoxy-based sealants.
APPENDIX A

VISUAL INSPECTION CHECK LIST
VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT  BETHLEHEM DAM

DATE  November 14, 1978

TIME

WEATHER  Cloudy - 45°

W.S. ELEV.  U.S.  DN.S.

PARTY:

1. James H. Maynes  D-H
2. James A. Dohrman  D-H
3. Vern Clifford  D-H
4. Gonzalo Castro  GEI
5. Ken Stern, New Hampshire  
   Water Resources Board

PROJECT FEATURE INSPECTED BY  REMARKS

1. 
2. 
3. 
4. 
5. 
6. 
7. 
8. 
9. 
10. 

A-1
PERIODIC INSPECTION CHECK LIST

PROJECT  BETHLEHEM DAM                      DATE  November 14, 1978

PROJECT FEATURE  NAME

DISCIPLINE  NAME

<table>
<thead>
<tr>
<th>AREA EVALUATED</th>
<th>CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAM EMBANKMENT - CONCRETE SPILLWAY</td>
<td>*Water was flowing over spillway.</td>
</tr>
<tr>
<td>Crest Elevation</td>
<td>1134.6</td>
</tr>
<tr>
<td>Current Pool Elevation</td>
<td>1135 +</td>
</tr>
<tr>
<td>Maximum Impoundment to Date</td>
<td>5.5 Acres +</td>
</tr>
<tr>
<td>Surface Cracks</td>
<td>None observed from surface (some cracks observed from inside of core).</td>
</tr>
<tr>
<td>Pavement Condition</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Movement or Settlement of Crest</td>
<td>None observed.</td>
</tr>
<tr>
<td>Lateral Movement</td>
<td>None observed.</td>
</tr>
<tr>
<td>Vertical Alignment</td>
<td>Good.</td>
</tr>
<tr>
<td>Horizontal Alignment</td>
<td>Good.</td>
</tr>
<tr>
<td>Condition at Abutment and at Concrete</td>
<td>Good.</td>
</tr>
<tr>
<td>Structures</td>
<td></td>
</tr>
<tr>
<td>Indications of Movement of Structural</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Items on Slopes</td>
<td></td>
</tr>
<tr>
<td>Trespassing on Slopes</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Sloughing or Erosion of Slopes or</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Abutments</td>
<td></td>
</tr>
<tr>
<td>Rock Slope Protection - Riprap</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Failures</td>
<td></td>
</tr>
<tr>
<td>Unusual Movement or Cracking at or</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Near Toes</td>
<td></td>
</tr>
<tr>
<td>Unusual Embankment or Downstream</td>
<td>None observed.</td>
</tr>
<tr>
<td>Seepage</td>
<td></td>
</tr>
<tr>
<td>Piping or Boils</td>
<td>None observed.</td>
</tr>
<tr>
<td>Foundation Drainage Features</td>
<td>Drain holes provided for hollow core.</td>
</tr>
<tr>
<td>Toe Drains</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Instrumentation System</td>
<td></td>
</tr>
</tbody>
</table>

A-2
## PERIODIC INSPECTION CHECK LIST

### PROJECT
**BETHLEHEM DAM**

### DATE
November 14, 1978

### PROJECT FEATURE

### DISCIPLINE

### NAME

<table>
<thead>
<tr>
<th>AREA EVALUATED</th>
<th>CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OUTLET WORKS - GATE BUILDING</strong></td>
<td></td>
</tr>
<tr>
<td>a. Concrete and Structural</td>
<td></td>
</tr>
<tr>
<td>General Condition</td>
<td>Fair to good.</td>
</tr>
<tr>
<td>Condition of Joints</td>
<td>Fair to good.</td>
</tr>
<tr>
<td>Spalling</td>
<td>Fair to good.</td>
</tr>
<tr>
<td>Visible Reinforcing</td>
<td>Minor at outside pool elevation, assumed to be caused by ice.</td>
</tr>
<tr>
<td>Rusting or Staining of Concrete</td>
<td>None observed.</td>
</tr>
<tr>
<td>Any Seepage or Efflorescence</td>
<td>None observed.</td>
</tr>
<tr>
<td>Joint Alignment</td>
<td>None observed.</td>
</tr>
<tr>
<td>Unusual Seepage or Leaks in Gate Chamber</td>
<td>Good.</td>
</tr>
<tr>
<td>Cracks</td>
<td>Concrete at main gate was eroded and leaking badly. Penstock gate was tight.</td>
</tr>
<tr>
<td>Rusting or Corrosion of Steel</td>
<td>None observed.</td>
</tr>
<tr>
<td>b. Mechanical and Electrical</td>
<td>Minimal.</td>
</tr>
<tr>
<td>Air Vents</td>
<td>All mechanical and electrical apparatus at old gate house has been removed or rendered inoperable by vandalism. Gates are in closed position without on-site lifting mechanism</td>
</tr>
<tr>
<td>Float Wells</td>
<td></td>
</tr>
<tr>
<td>Crane Hoist</td>
<td></td>
</tr>
<tr>
<td>Elevator</td>
<td></td>
</tr>
<tr>
<td>Hydraulic System</td>
<td></td>
</tr>
<tr>
<td>Service Gates</td>
<td></td>
</tr>
<tr>
<td>Emergency Gates</td>
<td></td>
</tr>
<tr>
<td>Lightning Protection System</td>
<td></td>
</tr>
<tr>
<td>Emergency Power System</td>
<td></td>
</tr>
<tr>
<td>Wiring and Lighting System in Gate Chamber</td>
<td></td>
</tr>
<tr>
<td>AREA EVALUATED</td>
<td>CONDITION</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>OUTLET WORKS - CONDUIT</td>
<td>Original 72&quot; diameter steel penstock has been removed for scrap. Penstock gate is down and tight.</td>
</tr>
<tr>
<td>General Condition of Concrete</td>
<td></td>
</tr>
<tr>
<td>Rust or Staining on Concrete</td>
<td></td>
</tr>
<tr>
<td>Spalling</td>
<td></td>
</tr>
<tr>
<td>Erosion or Cavitation</td>
<td></td>
</tr>
<tr>
<td>Cracking</td>
<td></td>
</tr>
<tr>
<td>Alignment of Monoliths</td>
<td></td>
</tr>
<tr>
<td>Alignment of Joints</td>
<td></td>
</tr>
<tr>
<td>Numbering of Monoliths</td>
<td></td>
</tr>
</tbody>
</table>
**PERIODIC INSPECTION CHECK LIST**

<table>
<thead>
<tr>
<th>PROJECT FEATURE</th>
<th>DISCIPLINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BETHLEHEM DAM</td>
<td></td>
</tr>
</tbody>
</table>

**DATE**  
November 14, 1978  
**NAME**

<table>
<thead>
<tr>
<th>AREA EVALUATED</th>
<th>CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUTLET CHANNEL</td>
<td>Energy dissipator, then natural channel. Signs of extensive ice jamming were observed on both downstream banks at elevations above the spillway crest, indicating a downstream pool is formed during ice jamming.</td>
</tr>
<tr>
<td>General Condition of Concrete</td>
<td></td>
</tr>
<tr>
<td>Rust or Staining</td>
<td></td>
</tr>
<tr>
<td>Spalling</td>
<td></td>
</tr>
<tr>
<td>Erosion or Cavitation</td>
<td></td>
</tr>
<tr>
<td>Visible Reinforcing</td>
<td></td>
</tr>
<tr>
<td>Any Seepage or Efflorescence</td>
<td></td>
</tr>
<tr>
<td>Condition at Joints</td>
<td></td>
</tr>
<tr>
<td>Drain Holes</td>
<td></td>
</tr>
<tr>
<td>Channel</td>
<td></td>
</tr>
<tr>
<td>Loose Rock or Trees Overhanging Channel</td>
<td></td>
</tr>
<tr>
<td>Condition of Discharge Channel</td>
<td></td>
</tr>
</tbody>
</table>
PERIODIC INSPECTION CHECK LIST

**PROJECT** BETHLEHEM DAM  
**DATE** November 14, 1978

**PROJECT FEATURE**  
**DISCIPLINE**

<table>
<thead>
<tr>
<th>AREA EVALUATED</th>
<th>CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</td>
<td>Not applicable - run-of-river dam.</td>
</tr>
</tbody>
</table>

a. Approach Channel  
   General Condition  
   Loose Rock Overhanging Channel  
   Trees Overhanging Channel  
   Floor of Approach Channel

b. Weir and Training Walls  
   General Condition of Concrete  
   Rust or Staining  
   Spalling  
   Any Visible Reinforcing  
   Any Seepage or Efflorescence  
   Drain Holes

c. Discharge Channel  
   General Condition  
   Loose Rock Overhanging Channel  
   Trees Overhanging Channel  
   Floor of Channel  
   Other Obstructions
**PERIODIC INSPECTION CHECK LIST**

**PROJECT**  BETHLEHEM DAM  
**DATE**  November 14, 1978

**PROJECT FEATURE**  
**DISCIPLINE**  

<table>
<thead>
<tr>
<th>AREA EVALUATED</th>
<th>CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE</td>
<td>Not applicable - run-of-river dam.</td>
</tr>
<tr>
<td>a. Approach Channel</td>
<td></td>
</tr>
<tr>
<td>Slope Conditions</td>
<td></td>
</tr>
<tr>
<td>Bottom Conditions</td>
<td></td>
</tr>
<tr>
<td>Rock Slides or Falls</td>
<td></td>
</tr>
<tr>
<td>Log Boom</td>
<td></td>
</tr>
<tr>
<td>Debris</td>
<td></td>
</tr>
<tr>
<td>Condition of Concrete Lining</td>
<td></td>
</tr>
<tr>
<td>Drains or Weep Holes</td>
<td></td>
</tr>
<tr>
<td>b. Intake Structure</td>
<td></td>
</tr>
<tr>
<td>Condition of Concrete</td>
<td></td>
</tr>
<tr>
<td>Stop Logs and Slots</td>
<td></td>
</tr>
<tr>
<td>AREA EVALUATED</td>
<td>CONDITION</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>OUTLET WORKS - SERVICE BRIDGE</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>a. Super Structure</td>
<td></td>
</tr>
<tr>
<td>Bearings</td>
<td></td>
</tr>
<tr>
<td>Anchor Bolts</td>
<td></td>
</tr>
<tr>
<td>Bridge Seat</td>
<td></td>
</tr>
<tr>
<td>Longitudinal Members</td>
<td></td>
</tr>
<tr>
<td>Under Side of Deck</td>
<td></td>
</tr>
<tr>
<td>Secondary Bracing</td>
<td></td>
</tr>
<tr>
<td>Deck</td>
<td></td>
</tr>
<tr>
<td>Drainage System</td>
<td></td>
</tr>
<tr>
<td>Railings</td>
<td></td>
</tr>
<tr>
<td>Expansion Joints</td>
<td></td>
</tr>
<tr>
<td>Paint</td>
<td></td>
</tr>
<tr>
<td>b. Abutment and Piers</td>
<td></td>
</tr>
<tr>
<td>General Condition of Concrete</td>
<td></td>
</tr>
<tr>
<td>Alignment of Abutment</td>
<td></td>
</tr>
<tr>
<td>Approach to Bridge</td>
<td></td>
</tr>
<tr>
<td>Condition of Seat and Backwall</td>
<td></td>
</tr>
</tbody>
</table>
PERIODIC INSPECTION CHECK LIST

PROJECT: BETHLEHEM DAM  DATE: November 14, 1978
PROJECT FEATURE  DISCIPLINE  NAME

<table>
<thead>
<tr>
<th>AREA EVALUATED</th>
<th>CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESERVOIR</td>
<td></td>
</tr>
<tr>
<td>Stability of Shoreline</td>
<td>Generally good - some animal (beaver) habitation indicated on right upstream bank.</td>
</tr>
<tr>
<td>Sedimentation</td>
<td>Extensive sedimentation - average depth of impoundment is 2-5 feet.</td>
</tr>
<tr>
<td>Changes in Watershed Runoff Potential</td>
<td></td>
</tr>
<tr>
<td>Upstream Hazards</td>
<td>None observed.</td>
</tr>
<tr>
<td>Downstream Hazards</td>
<td>None.</td>
</tr>
<tr>
<td>Alert Facilities</td>
<td>None observed.</td>
</tr>
<tr>
<td>Hydrometeorological Gages</td>
<td>None.</td>
</tr>
<tr>
<td>Operational and Maintenance Regulations</td>
<td>None known.</td>
</tr>
</tbody>
</table>

NOTE: Excessive sedimentation was found inside the dam core. It was determined through discussions with the former owner (Public Service) that the sediment is washed in through the drains during winter when a downstream pool is created by ice jamming. This could not be confirmed by the visual inspection and further investigation is recommended.
APPENDIX B

PROJECT RECORDS AND PLANS

1. Listing of Design, Construction and Maintenance Records:
   a. Construction Summary – May 25, 1927
   b. Specification Abstract – July 30, 1925

2. Copies of Past Inspection Reports:
   a. New Hampshire Water Resources Board – August 14, 1936

3. Plan:
   a. Selected Details from Original Construction Drawings
Specifications for Dam, Headgates & Abutments
Bethlehem Electric Co.
Bethlehem, N.H.
July 30, 1925

The work covered by this specification includes:

1. The building of a concrete and reinforced concrete dam in the Ammonoosuc River near Bethlehem Hollow, N. H.

2. The removal of old crib work and masonry, and the reconstruction of the present headgate structure.

3. The removal of the old crib work and the construction of new wing walls and embankments on the both ends of the dam.

4. The construction of a new wastegate on the right end of the dam.

5. The setting of all iron work, gate frames, anchor bolts, etc. required above.

6. All other work including coffer dam and pumping for excavation of foundation that may be a part of the above.

7. All extra work that may be ordered by the engineer from time to time.

All work is to be done in accordance with these specifications and substantially as shown on plan prepared by the engineer and numbered File 954-3, No. 1 dated May 21 and revised Aug. 1st 1925 which is hereby made a part of these specifications and under the supervision of the engineer.
Bethlehem, N. H.

Bethlehem Electric Company.

I-1682 Construction of dam on the Ammonoosuc River near Bethlehem Junction.

Ambursen type, concrete dam, built downstream adjacent to old log dam, the excavation for the concrete mat and core wall were carried down into earth material containing sufficient clay to insure a practically impervious sub-foundation.

The contractors began actual work in August 1925 and finished in February 1926; first concrete poured September 2, 1925; last, poured February 13, 1926.

Total elapsed time 165 days; total concrete 3855.5 cubic yards; average progress 23.36 cu. yds. per day.

Total days, cement poured 82; total cu. yds. poured 3855.5, average progress based on days poured 47.01 cu. yds. per day.

The south earth dike was completed during the season of 1926, scouring at the toe of the concrete apron progressed to such a point that it became necessary to provide protection; this was done by building a timber rock filled crib along the toe of the apron; a crib was also built along the river side of the penstock, this work was completed during November 1926.

References: Plans; D-1385; Correspondence, etc., I-1682; Daily Reports, Progress Views, Cement, sand, gravel and concrete tests and memoranda, see I-1682 Bethlehem Electric Co. file.

May 25, 1927.

Syl: CMG

[Signature]
DATA ON WATER POWER DEVELOPMENTS IN NEW HAMPSHIRE

LOCATION

<table>
<thead>
<tr>
<th>Town</th>
<th>County</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bethlehem</td>
<td>Crafton</td>
</tr>
</tbody>
</table>

Stream: Jersa, Ammonoosuc River

sin-Primary: Corn. 3

Local Name:..........................

GENERAL DATA

ead-Max. 45 ft.; Min. 42 ft.; Ave. ........................................ ft.

Date of Construction: Use of Power: Public Utility

ondage: ac. ft.; Storage: ac. ft.

DESCRIPTION

Size of Rack Opening: Material

Size of Bar: Material

Area: Gross Sq. Ft.: Net sq. ft.

Head Gates

Type:........................................

Number: Size ft. high x ft. wide

Elevation of Invert: Total Area sq. ft.

Hoist:..........................

Penstock

Number: 1 Material (Penstock to Power House)

Size: Length 1000

Turbines

Number: Makers: S. Hannon Smith

Rating HP. per unit: Total Capacity HP.

Max. Dement C.F.S., per unit: Total cfs.

Drive

Type:..........................

Generator

Number: 1

Make: G.E.

Rating KW., per unit: Total Capacity 300 K. W.

Exciter

Number:........................................ Make

Rating-per unit: Total Capacity K. W.

INPUT—KWHRS

19........................... 19..........................
19.......................... 19..........................
19.......................... 19..........................
19.......................... 19..........................
19.......................... 19..........................
19.......................... 19..........................

OWNER: Public Service Co. of N.H. Manchester, N.H.
NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION

Town ...........................................: County ..............................
Stream ........................................: Basin-Primary ..................
...........................................: Secondary ................................
Local Name ..................................: Coordinates—Lat. ....: Long.
........................................................................................

STATE NO. ..................................

GENERAL DATA

Drainage area: Controlled ............... Sq. Mi.: Uncontrolled ............... Sq. Mi.: Total ........ Sq. Mi.
Overall length of dam ............... ft.: Date of Construction ...........
Height: Stream bed to highest elev. ............... ft.: Max. Structure ............... ft.
Cost—Dam ......................................: Reservoir

DESCRIPTION

Amberston Type—Concrete

Waste Gates

Type ...........................................
Number ..........: Size .......... ft. High x .......... ft. wide
Elevation Invert ................................: Total Area ........ sq. ft.
Hoist ...........................................

Waste Gates Conduit

Number ......................................: Materials ...................................
Size ............... ft.: Length ............... ft.: Area ........ sq. ft.

Embankment

Type ...........................................
Height—Max. .......... ft.: Min. ............... ft.
Slopes—Upstream on .......... : Downstream on ...........
Length—Right of Spillway .......... : Left of Spillway ...........

Spillway

Materials of Construction  Concrete

Length—Total .......... ft.: Net .......... ft
Height of permanent section—max. .......... ft.: Min. .......... ft.
Flashboards—Type ................................: Height .......... ft
Elevation—Permanent Crest ................................: Top of Flashboard

Flood Capacity ........... cfs: ........... cfs/sq. mi.

Abutments

Materials: ................................

Headworks to Power Devel.—(See “Data on Power Development”)

OWNER ..................................................: Manchester, N.H.

REMARKS  Used for Public Utilities—Power
PUBLIC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD I-5444

TOWN
BETULICHI

TOWN
NO. 1

STATE
NO. 4-5

RIVER
STREAM
Lower Amonoosuc River

DRAINAGE
AREA
83

POND
AREA

DAM
TYPE
Aburseen

FOUNDATION
NATURE OF
Earth

MATERIALS OF
CONSTRUCTION
Concrete

PURPOSE
OF DAM
POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTATION—PUBLIC UTILITY

HEIGHTS, TOP OF
DAM TO BED OF STREAM
Approx. 26'

TOP OF DAM TO
SPILLWAY CRESTS
9'

SPILLWAYS, LENGTHS
DEPTHS BELOW TOP OF DAM
140
1—Flood Gate 19' high x 3' wide

LENGTH
OF DAM Approx.

FLASHBOARDS
TYPE, HEIGHT ABOVE CREST
4'

OPERATING HEAD
CREST TO N. T. W.
42'

TO N. T. W.
46'

WHEELS, NUMBER
KINDS & H. P.
1—S. Morgan Smith—460 HP

GENERATORS, NUMBER
KINDS & K. W.
1—GE 300 K

M. P. 90 P. C. TIME
100 P. C. EFF.

REFERENCES, CASES,
PLANS, INSPECTIONS
I-1632

REMARKS

OWNER: Public Service Co. of N.H.

CONDITION: Good

MENACE: Over 25'. Subject to periodic inspection.

To the Public Service Commission:

The foregoing memorandums on the above dam is submitted covering inspection made Aug. 14, 1936, according to notification to owner dated Aug. 5, 1936, and bill for same is enclosed.

D. Waldo White
Chief Engineer

Aug. 20, 1936
Copy to Owner
**NEW HAMPSHIRE WATER RESOURCES BOARD**

**INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS**

**DAM**

- **BASIN**
- **RIVER**
- **TOWN**
- **LOCAL RAIL OF DAM**
- **BUILT**
- **25.01**

<table>
<thead>
<tr>
<th><strong>DAM</strong></th>
<th><strong>NO.</strong></th>
<th><strong>LILES FROM MOUTH</strong></th>
<th><strong>D.A.-SQ.MI.</strong></th>
</tr>
</thead>
</table>

- **POND AREA-ACRES**
- **DRAWDOOM-FT.**
- **POND CAPACITY-ACRE FT.**
- **HEIGHT-TO-BED OF STREAM-FT.**
- **MAX. MIN.**
- **OVERALL LENGTH OF DAM-FT.**
- **MAX. FLOOD HEIGHT ABOVE CREST-FT.**
- **PERMANENT CREST ELEV. U.S.G.S.**
- **LOCAL GAGE**
- **TAILWATER ELEV. U.S.G.S.**
- **LOCAL GAGE**

- **SPILLWAY LENGTHS-FT.**
- **FREEBOARD-FT.**

- **FLASHBOARDS-TYPE, HEIGHT ABOVE CREST**
- **MAX. OPENING DEPTH SILL BELOW CREST**

- **WASTE GATES-NO.**
- **WIDTH MAX. OPENING**

- **REMARKS**

**POWER DEVELOPMENT**

<table>
<thead>
<tr>
<th><strong>UNITS NO.</strong></th>
<th><strong>RATED</strong></th>
<th><strong>HEAD</strong></th>
<th><strong>C.F.S.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1500</td>
<td>40</td>
<td>93.2</td>
</tr>
<tr>
<td></td>
<td>1500</td>
<td>40</td>
<td>93.2</td>
</tr>
</tbody>
</table>

- **USE**

- **REMARKS**

- **DATE**

---

- **Pond Area-Acres**
- **Drawdown-FT.**
- **Pond Capacity-Acre FT.**
- **Height-To-Bed Of Stream-FT.**
- **Max. Min.**
- **Overall Length Of Dam-FT.**
- **Max. Flood Height Above Crest-FT.**
- **Permanent Crest Elev. U.S.G.S.**
- **Local Gage**
- **Tailwater Elev. U.S.G.S.**
- **Local Gage**

- **Spillway Lengths-FT.**
- **Freeboard-FT.**

- **Flashboards-Type, Height Above Crest**
- **Max. Opening Depth Sill Below Crest**

- **Waste Gates-No.**
- **Width Max. Opening**

- **Remarks**

- **Power Development**

- **Units No.**
- **Rated**
- **Head**
- **C.F.S.**

- **Use**

- **Remarks**

- **Date**
DAM SAFETY INSPECTION REPORT FORM

Town: Battle Lake Dam Number: 2501

Inspected by: \( \text{Inspected by: } \) Date: \( 18 \text{ July, 1974} \)

Local name of dam or water body: Concord, N. H. 03301

Owner: Arnold Polanski Address:

Owner was/was not interviewed during inspection.

Drainage Area: \( \text{sq. mi.} \) Stream:

Fond Area: \( \text{Ac}-\text{Pt. Max. Head } \frac{\text{Acre}}{\text{sq. ft.}} \)

Foundation: Type \( \) Seepage present at toe - Yes\( \sqrt{\text{No}} \)

Spillway: Type \( \) Over \( \text{Fl.} \) Freeboard over perm. crest: \( 9 \)

Width \( 140 \) Flashboard height

Max. Capacity \( \text{c.f.s.} \)

Embarkment: Type \( \) Cover \( \text{Width} \)

Upstream slope \( \) to 1; Downstream slope \( \) to 1

Abutments: Type \( \) Condition: Good, Fair, Poor

Gates or Pond Drain: Size \( 19' \times 8' \) Capacity \( \text{Type Gate} \)

Lifting apparatus \( \) Operational condition \( ? \)

Changes since construction or last inspection:

Downstream development:

This dam \( \text{would/would not be a menace if it failed.} \)

Suggested reinspection date:

Remarks: \( \text{Not Used For Power Gate No.} \text{ walk.} \)

Concrete \( \text{and Guts. Lower Gould} \)

---
APPENDIX C

PHOTOGRAPHS
#1. VIEW OF SPILLWAY AND GATE WORKS

#2. VIEW OF LEFT SIDE SPILLWAY SHOWING ERODED JOINT

C-1
#3. View of Dam Interior showing walkway and sediment buildup

#4. View of downstream side of first compartment (right side)
#5. VIEW OF GATE WORKS AND RIGHT SIDE SPILLWAY

#6. VIEW OF WASTE GATE AND SLUICEWAY
#7. UPSTREAM VIEW OF GATE WORKS AND CORE WALL

#8. VIEW OF LEFT CORE WALL
#9. VIEW OF OLD PENSTOCK SECTION

#10. GENERAL VIEW OF UPSTREAM RESERVOIR

C-5
#11. VIEW OF DOWNSTREAM CHANNEL

#12. OVERHEAD VIEW OF DAM, UPSTREAM AND DOWNSTREAM CHANNELS
APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS
SIZE AND STORAGE ESTIMATE

NORMAL LENGTH = 1700 FEET (ESTIMATED FROM AERIAL PHOTOGRAPH)

AVERAGE WIDTH = 140 FEET (ESTIMATED FROM AERIAL PHOTOGRAPHS)

AVERAGE DEPTH = 4 FEET

NORMAL IMPOUNDMENT AREA = 1700 x 140 = 238,000 FT²

NORMAL IMPOUNDMENT STORAGE = 5.46 ACRES

MAXIMUM POOL IMPOUNDMENT

ASSUME LENGTH INCREASES TO 2800 FEET
WIDHT REMAINS 140 FEET

ESTIMATE DEPTH = 4' + 9' = 13 FEET

MAX. POOL AREA = 2800 x 140 = 392,000 = 8.99 AC

MAX. STORAGE = 8.99 x 13 = 116 AC-FEET
DRAINAGE AREA: FROM WATER RESOURCES, DRAINAGE AREA FOR THE GAGING STATION IS 87.6 MI$^2$.

NEED TO ADD DRAINAGE AREA FROM THERE TO DAM.

PLANIMETRIC MOLING, 8.7:

SCALE 1:62,500

$\Delta \theta = 97.3^\circ$

$8.7(1.973) = 8.13$

$8.48 + 87.6 = 96.0\text{ MI}$

DATE CLASSIFICATION:

CFS: 29

SURFACE: 110 AC-FEET

SMALL

HOMES DOWNSTREAM ARE NOT WITHIN FLOOD PLAIN.
For Small Dam with Low Hazard

TEST FLOOD 50-100yr FREQ FLOOD

From Computer Run 100yr Flood = 15,973 cfs

Elev of brinkwall = 100

Elev of weir top = 106.5

\( Q = CLh^{3/2} \)

Design \( h = 7 \)

\( C \) values from "Hydraulics" Vol. 2

\[
\begin{align*}
h & = 0.0 & Q & = 0 \\
& 1 & Q & = (0.6)(2.5)(100)(1)^{3/2} = 437.5,200 \\
& 2 & Q & = (0.6)(2.5)(100)(2)^{3/2} = 13,750,200 \\
& 3 & Q & = (0.6)(2.5)(100)(3)^{3/2} = 25,884,600 \\
& 4 & Q & = (0.6)(2.5)(100)(4)^{3/2} = 40,122,000 \\
& 5 & Q & = (0.6)(2.5)(100)(5)^{3/2} = 55,049,000 \\
& 6 & Q & = (0.6)(2.5)(100)(6)^{3/2} = 69,435,000 \\
& 7 & Q & = (0.6)(2.5)(100)(7)^{3/2} = 82,227,000 \\
& 8 & Q & = (0.6)(2.5)(100)(8)^{3/2} = 93,333,000 \\
& 9 & Q & = (0.6)(2.5)(100)(9)^{3/2} = 102,785,000 \\
& 10 & Q & = (0.6)(2.5)(100)(10)^{3/2} = 109,880,000 \\
& 11 & Q & = 11,429,600 \\
& 12 & Q & = 11,429,600 \\
\end{align*}
\]
\[ h = 9.2 \quad Q = 1.05(3.9)(140)(9.2)^{1.2} = 15,998 \]

\[ + 2.5(2)(140)(0.2)^{1.2} \quad \text{TOTAL} \quad 16,208 \]

\[ \text{Flow through dam} = \left( \frac{\text{Diameter}}{4 \times \text{flow in cubic ft}} \right) \text{flow in cubic ft in} \]

\[ V = \text{Volume in cubic ft} \quad \text{Volume in cubic ft} \]

\[ Q_{\text{flow dam}} = \left( \frac{2.54(1)^{2}}{81.6} \right)(15,998) = 16,208 \]

\[ \text{Flow through dam} = 16,208 \]
DAM FAILURE ANALYSIS

NORMAL CONDITIONS — WATER LEVEL @ SPILLWAY CREST ELEVATION

STREAMBED CLEV = 80.0
SPILLWAY CREST CLEV = 100.0

\[ \gamma_0 = 20', \quad \text{LENGTH} = 140' \text{ (Spillway)} \]

\[ Q = \frac{\gamma_0 W L}{g} \left[ \frac{\gamma}{g} \right]^{1/2} = \frac{9.81 (20)(140)}{9.81 (100)^{1/2}} = 817' \]

INITIAL FLOW RATE = \( \frac{1}{2} (20) = 13.2' \)
BANKS ARE 20' HIGH — NO OVERFLOW FLOW

THE "C. 22 PM" CONDITIONS — WATER LEVEL @ TOP OF ABRIDGMENTS (CLEV

\[ \gamma_0 = 28', \quad W = 190' \]
\[ \text{WIDE AT SPILLWAY} = 190' \]
\[ \text{HEIGHT OF ABRIDGMENT} = (4/140)' = 0.2' \]

DISCHARGE REQUIRED TO BE AT TOP IN DAM: \( Q = \frac{\gamma_0 W L}{g} \left[ \frac{\gamma}{g} \right]^{1/2} = 9.81 (20)(140) = 12.2' \)

DISCHARGE OVER SPILLWAY OVER SKEW PLANE: \( Q = 664' \quad \text{TOTAL FLOW RATE} = 12.2 + 664 = 791' \)

INCREASE DUE TO FAILURE = 21,363 - 12.2 = 863.4'

HYDRAULIC CHAIN OF CURRENT = \( H = \frac{(1217.8)^{1/2}}{(664)(863.4)} = 17.3' \)

VELOCITY BEHIND DAM = \( V = \frac{(H - 17.3)}{21.8} = 96 \text{ FEET-SECOND} \)
### Flood Flow Frequency Computation

**Gilford Ammonoosuc River at Bethlehem Junction, New Hampshire**

<table>
<thead>
<tr>
<th>N</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Computed Skew</th>
<th>Regional Skew</th>
<th>Adopted Skew</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.622</td>
<td>0.2625</td>
<td>0.3723</td>
<td>0.500</td>
<td>0.4779</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Computed Flow</th>
<th>Expected Probability Flow</th>
<th>Probability</th>
<th>0.05 Limit</th>
<th>0.95 Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2115.6</td>
<td>21.15</td>
<td>0.002</td>
<td>31456.</td>
<td>15936.</td>
</tr>
<tr>
<td>17184</td>
<td>1718</td>
<td>0.005</td>
<td>24539.</td>
<td>13370.</td>
</tr>
<tr>
<td>14518</td>
<td>1451</td>
<td>0.010</td>
<td>28016.</td>
<td>14634.</td>
</tr>
<tr>
<td>12516</td>
<td>1251</td>
<td>0.020</td>
<td>16389.</td>
<td>10036.</td>
</tr>
<tr>
<td>10236</td>
<td>1023</td>
<td>0.040</td>
<td>13148.</td>
<td>8555.</td>
</tr>
<tr>
<td>7941</td>
<td>794</td>
<td>0.100</td>
<td>9553.</td>
<td>6740.</td>
</tr>
<tr>
<td>6194</td>
<td>619</td>
<td>0.200</td>
<td>7285.</td>
<td>5427.</td>
</tr>
<tr>
<td>4115</td>
<td>411</td>
<td>0.500</td>
<td>4949.</td>
<td>3415.</td>
</tr>
<tr>
<td>2566</td>
<td>256</td>
<td>0.800</td>
<td>3276.</td>
<td>2430.</td>
</tr>
<tr>
<td>2415</td>
<td>241</td>
<td>0.950</td>
<td>2501.</td>
<td>1724.</td>
</tr>
<tr>
<td>1714</td>
<td>171</td>
<td>0.999</td>
<td>2963.</td>
<td>1329.</td>
</tr>
</tbody>
</table>

Flow in cubic feet per second.
<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
<th>Value 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>44.16</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.06</td>
<td>34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.75</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>44.68</td>
<td>34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51.21</td>
<td>91</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29.54</td>
<td>45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50.28</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>44.68</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51.21</td>
<td>91</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29.54</td>
<td>45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50.28</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>44.68</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51.21</td>
<td>91</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29.54</td>
<td>45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50.28</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>44.68</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51.21</td>
<td>91</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29.54</td>
<td>45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50.28</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Final Results**
APPENDIX E

Information as Contained in the National Inventory of Dams
<table>
<thead>
<tr>
<th>STATE</th>
<th>COUNTY</th>
<th>ORIGNAL NAME</th>
<th>NAME</th>
<th>LATITUDE</th>
<th>LONGITUDE</th>
<th>REPORT DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>KELLHINEM DAM</td>
<td></td>
<td>7139.0</td>
<td>10/11/74</td>
</tr>
</tbody>
</table>

**POPULAR NAME**: KELLHINEM DAM

**NAME OF IMPOUNDMENT**: KELLHINEM DAM

**RECON.BASIN**: [Field not filled]

**RIVER OR STREAM**: [Field not filled]

**NEAREST DOWNSTREAM CITY-TOWN-VILLAGE**: [Field not filled]

**DIST. FROM DAM**: [Field not filled]

**HABITAT**: [Field not filled]

**POPULATION**: [Field not filled]

**TYPE OF DAM**: [Field not filled]

**YEAR COMPLETED**: [Field not filled]

**PURPOSES**: [Field not filled]

**STATE HYDRO**: [Field not filled]

**IMPONDING CAPACITIES**: [Field not filled]

**SUPERVISORY STAFF**: [Field not filled]

**HYDRAULIC DATA**: [Field not filled]

**REMARKS**: TIMEATES IMPONDABLE