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NEW JERSEY DEPT OF ENVIRONMENTAL PROTECTION TRENTON --ETC F/6 13/13  
NATIONAL DAM SAFETY PROGRAM. SMITHVILLE DAM (NJ 00043) DELAWARE--ETC(U)  
JUL 81 R J MCDERMOTT, J E GRIBBIN DACW61-79-C-8011

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DELAWARE RIVER BASIN  
NORTH BRANCH RANCOCAS CREEK  
BURLINGTON COUNTY  
NEW JERSEY

AD A103760

# SMITHVILLE DAM

## NJ 00043

PHASE 1 INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM



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DEPARTMENT OF THE ARMY

Philadelphia District  
Corps of Engineers  
Philadelphia, Pennsylvania

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| REPORT DOCUMENTATION PAGE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                | READ INSTRUCTIONS<br>BEFORE COMPLETING FORM |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|---------------------------------------------|
| 1. REPORT NUMBER<br>DAEN/NAE-53842/NJ00043-81/07                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 2. GOVT ACCESSION NO.<br>AD-A103760                            | 3. RECIPIENT'S CATALOG NUMBER               |
| 4. TITLE (and Subtitle)<br>Phase I Inspection Report<br>National Dam Safety Program<br>Smithville Dam, NJ00043<br>Burlington County, N.J.                                                                                                                                                                                                                                                                                                                                                                                                                                        | 5. TYPE OF REPORT & PERIOD COVERED<br>9 FINAL Rept.            |                                             |
| 7. AUTHOR(s)<br>McDermott, Richard J. Dr. B.<br>Gribbin, John E. Dr. B.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 6. PERFORMING ORG. REPORT NUMBER                               |                                             |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>Storch Engineers<br>220 Ridgedale Ave.<br>Florham Park, N.J. 07932                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 8. CONTRACT OR GRANT NUMBER(s)<br>DACW61-79-C-0011             |                                             |
| 11. CONTROLLING OFFICE NAME AND ADDRESS<br>NJ Department of Environmental Protection<br>Division of Water Resources<br>P.O. Box CN029<br>Trenton, NJ 08625                                                                                                                                                                                                                                                                                                                                                                                                                       | 10. PROGRAM ELEMENT, PROJECT, TASK<br>AREA & WORK UNIT NUMBERS |                                             |
| 14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)<br>U.S. Army Engineer District, Philadelphia<br>Custom House, 2d & Chestnut Streets<br>Philadelphia, PA 19106                                                                                                                                                                                                                                                                                                                                                                                        | 12. REPORT DATE<br>Jul 81                                      |                                             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 13. NUMBER OF PAGES<br>50                                      |                                             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 15. SECURITY CLASS. (of this report)<br>Unclassified           |                                             |
| 16. DISTRIBUTION STATEMENT (of this Report)<br>Approved for public release; distribution unlimited.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                |                                             |
| 17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20; if<br>National Dam Safety Program,<br>Smithville Dam (NJ 00043) Delaware<br>River Basin, North Branch Rancocas Creek,<br>Burlington County, New Jersey. Phase I<br>Inspection Report.                                                                                                                                                                                                                                                                                                                           |                                                                |                                             |
| 18. SUPPLEMENTARY NOTES<br>Copies are obtainable from National Technical Information Service,<br>Springfield, Virginia 22151.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                |                                             |
| 19. KEY WORDS (Continue on reverse side if necessary and identify by block number)<br>Dams<br>Embankments<br>Visual Inspection<br>Structural Analysis<br>National Dam Safety Program<br>Smithville Dam, N.J.<br>Spillways                                                                                                                                                                                                                                                                                                                                                        |                                                                |                                             |
| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number)<br>This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report. <i>not page</i> |                                                                |                                             |



IN REPLY REFER TO

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DEPARTMENT OF THE ARMY  
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS  
CUSTOM HOUSE-20 & CHESTNUT STREETS  
PHILADELPHIA, PENNSYLVANIA 19106

Honorable Brendan T. Byrne  
Governor of New Jersey  
Trenton, New Jersey 08621

24 AUG 1981

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Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Smithville Dam in Burlington County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Smithville Dam, a high hazard potential structure, is judged to be in fair overall condition. The dam's spillway is considered inadequate because a flow equivalent to 9 percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is one half of the Probable Maximum Flood). The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the determination that dam failure resulting from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway is inadequate but more detailed hydraulic and hydrologic studies are recommended only in connection with studies of other dams in the same drainage system and with structural stability investigations outlined below.

b. Within one year from the date of approval of this report the owner should engage a qualified professional consultant to investigate the structural stability including consideration of the effect of overtopping of the dam. As a result of the investigation, the need for and type of remedial measures should be determined and then implemented.

c. Within six months from the date of approval of this report, the following remedial actions should be initiated:

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Honorable Brendan T. Byrne

(1) The steel sheet piling abutments at each end of the dam should be renovated by cleaning, painting and replacement of the wales.

(2) The stabilization of the stream banks downstream from the dam should be renovated.

d. The owner of the dam should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam within one year from the date of approval of this report.

e. The existing emergency action plan and warning system should be put in writing within six months from the date of approval of this report and should include actions to be taken by the owner to minimize the downstream effects of an emergency at the dam.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Forsythe of the Sixth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

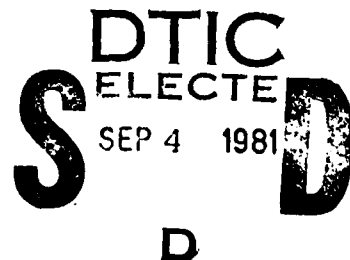


ROGER L. BALDWIN  
Lieutenant Colonel, Corps of Engineers  
Commander and District Engineer

1 Incl  
As stated

Copies furnished:  
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Division of Water Resources  
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Bureau of Flood Plain Regulation  
Division of Water Resources  
N.J. Dept. of Environmental Protection  
P.O. Box CN029  
Trenton, NJ 08625



SMITHVILLE DAM (NJ00043)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 6 January 1981 by Storch Engineers, under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Smithville Dam, a high hazard potential structure, is judged to be in fair overall condition. The dam's spillway is considered inadequate because a flow equivalent to 9 percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is one half of the Probable Maximum Flood). The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the determination that dam failure resulting from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway is inadequate but more detailed hydraulic and hydrologic studies are recommended only in connection with studies of other dams in the same drainage system and with structural stability investigations outlined below.

b. Within one year from the date of approval of this report the owner should engage a qualified professional consultant to investigate the structural stability including consideration of the effect of overtopping of the dam. As a result of the investigation, the need for and type of remedial measures should be determined and then implemented.

c. Within six months from the date of approval of this report, the following remedial actions should be initiated:

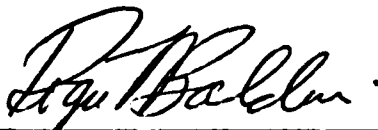
(1) The steel sheet piling abutments at each end of the dam should be renovated by cleaning, painting and replacement of the wales.

(2) The stabilization of the stream banks downstream from the dam should be renovated.

d. The owner of the dam should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam within one year from the date of approval of this report.

e. The existing emergency action plan and warning system should be put in writing within six months from the date of approval of this report and should include actions to be taken by the owner to minimize the downstream effects of an emergency at the dam.

APPROVED:



ROGER L. BALDWIN  
Lieutenant Colonel, Corps of Engineers  
Commander and District Engineer

DATE:

24 Aug 81

PHASE I REPORT  
NATIONAL DAM SAFETY PROGRAM

|                     |                             |
|---------------------|-----------------------------|
| Name of Dam:        | Smithville Dam, NJ00043     |
| State Located:      | New Jersey                  |
| County Located:     | Burlington                  |
| Drainage Basin:     | Delaware                    |
| Stream:             | North Branch Rancocas Creek |
| Date of Inspection: | January 6, 1981             |

Assessment of General Condition of Dam

Based on visual inspection, past operational performance and Phase I engineering analyses, Smithville Dam, a high hazard potential structure, is assessed as being in fair overall condition.

Hydraulic and hydrologic analyses indicate that the spillway is inadequate. Discharge capacity of the spillway is not sufficient to pass the designated spillway design flood (SDF) without an overtopping of the dam (The SDF for Smithville Dam is equal to one-half the probable maximum flood.)

The spillway is capable of passing approximately 4 percent of the probable maximum flood or 8 percent of the SDF. However, more detailed hydraulic and hydrologic studies are recommended only in connection with studies of other dams in the same drainage system and with structural stability investigations outlined below.

The owner should continue to employ the surveillance and emergency action plan currently in use. In the future, the plan should be reviewed and, after any necessary revisions, incorporated into a formal written plan.

In light of past failures of the dam and the recommendation in 1936 to drive significantly longer steel sheet piling, the structural stability of the dam should be investigated in the future by a professional engineer

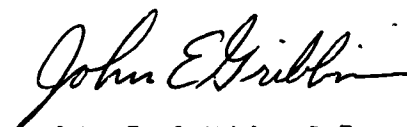
experienced in the design and construction of dams. The investigation should include consideration of the effects of overtopping during the SDF on the stability of the dam and adjacent stream banks. As a result of the investigation, the need for and type of remedial measures should be determined and then implemented.

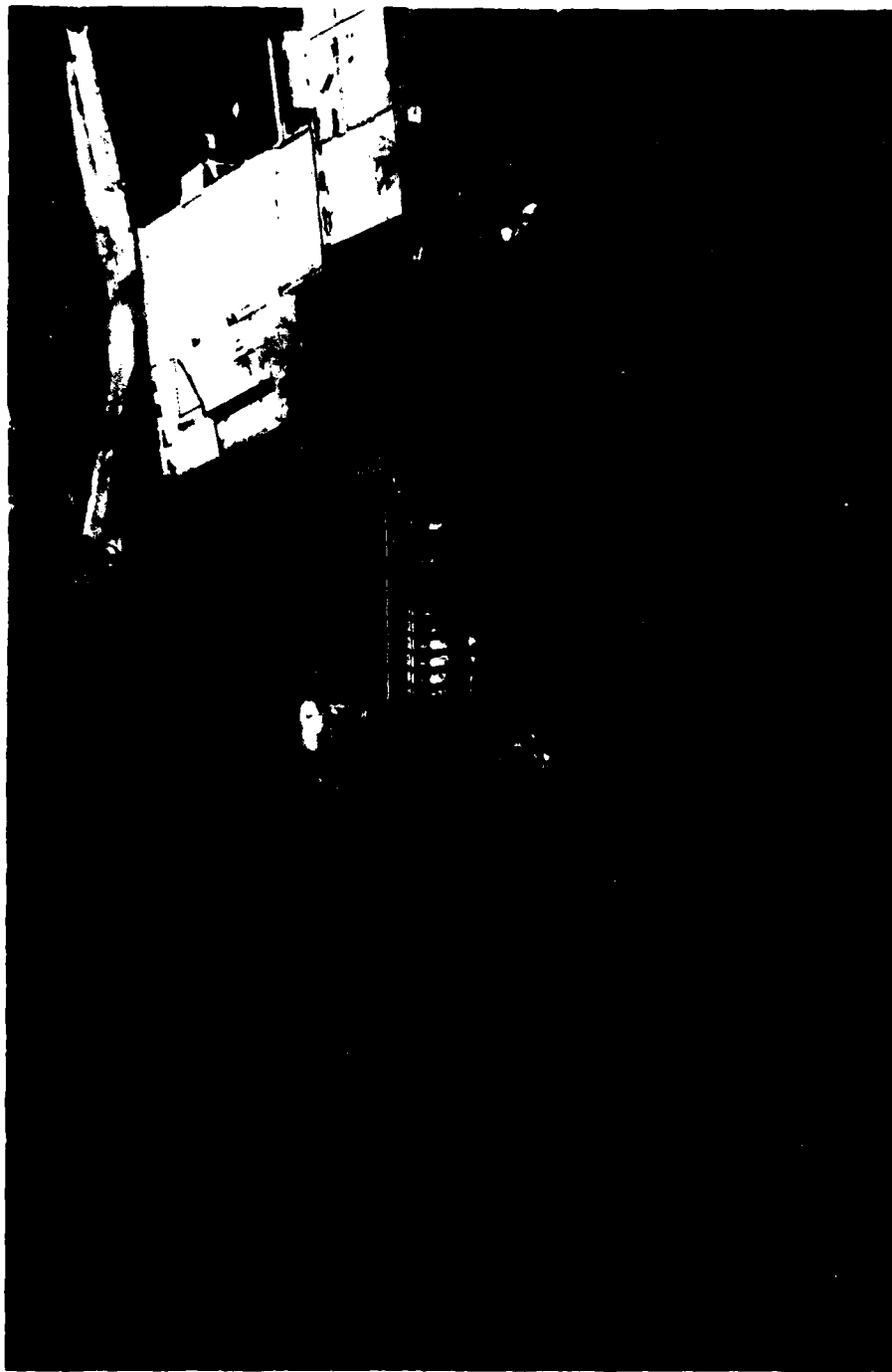
In addition, it is recommended that the following remedial measures be undertaken in the near future:

- 1) The steel sheet piling abutments at each end of the dam should be renovated by cleaning, painting and replacement of the wales.
- 2) The stabilization of the stream banks downstream from the dam should be renovated.

In the future, the owner of the dam should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

  
Richard J. McDermott, P.E.

  
John E. Gribbin, P.E.



OVERVIEW - SMITHVILLE DAM

31 JANUARY 1981

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## PREFACE

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

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of 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 the unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydraulic and hydrologic 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. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydraulic and hydrologic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

SMITHVILLE DAM, I.D. NJ00043

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The Division of Water Resources of New Jersey Department of Environmental Protection (NJDEP) in cooperation with the Philadelphia District of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the State of New Jersey. Storch Engineers has been retained by the NJDEP to inspect and report on a selected group of these dams. The NJDEP is under agreement with the Philadelphia District of the Corps of Engineers.

b. Purpose of Inspection

The visual inspection of Smithville Dam was made on January 6, 1981. The purpose of the inspection was to make a general assessment of the structural integrity and operational adequacy of the dam structure and its appurtenances.

## 1.2 Description of Project

### a. Description

Smithville Dam is a run-of-the river dam consisting of a series of twelve slide gates in a timber frame constructed across the North Branch Rancocas Creek. Steel sheet piling at each end serves as abutments and also as slope stabilization along the sides of the stream.

The elevation of the crest of the dam is 22.0 National Geodetic Vertical Datum (N.G.V.D.) while that of the top of the gates when closed is 18.6. The downstream channel bed elevation is 12.0. The overall length of dam is 60 feet and its height is 10.0 feet.

### b. Location

Smithville Dam is located in the Township of Eastampton, Burlington County, New Jersey. Constructed across North Branch, Rancocas Creek, the dam impounds that stream as well as Smithville Lake which is located adjacent to the dam with intake immediately upstream. Principal access is by local roads in Smithville approximately one mile west of N.J. Route 206.

### c. Size and Hazard Classification

The dam is classified in accordance with criteria presented in "Recommended Guidelines for Safety Inspection of Dams" published by the U.S. Army Corps of Engineers. Size categories consist of Small, Intermediate and Large while hazard categories are designated as Low, Significant and High.

Size Classification: Smithville Dam is classified as "Small" size since its maximum storage volume is 244 acre-feet (which is less than 1000 acre-feet) and its height is 10.0 feet (which is less than 40 feet).

Hazard Classification: Visual inspection of the downstream flood plain of the dam indicates that failure of the dam would inundate several dwellings located within 1 mile of the dam. Loss of more than a few lives is possible. In addition, dam failure during a storm equivalent to the SDF could cause property damage and inundation of dwellings located in Mount Holly approximately 2 miles from the dam. Accordingly, Smithville Dam is classified as "High" hazard.

d. Ownership

Smithville Dam is owned by the County of Burlington, R.D. #2, Maple Avenue, Mount Holly, New Jersey 08060.

e. Purpose of Dam

The purpose of the dam is the impoundment of a lake and stream used for recreation. During the summer months the lake is used as a municipal swimming facility.

f. Design and Construction History

The original Smithville Dam reportedly was constructed around 1780 for the purpose of supplying water to a nearby mill. The dam has been repaired or reconstructed on numerous occasions since the original construction. Dates of repair or reconstruction include 1934, 1937, 1941, 1953, 1969 and most recently 1980.

The dam repair of 1934 was performed in accordance with plans approved by the New Jersey State Water Policy Commission and was completed on September 24, 1934. The repair was accomplished by the H.B. Smith Machine Co., then owners of the dam and adjacent mill, for which the dam supplied water power. The dam repair included repair of the timber head gates which had failed on July 19, 1933. The information concerning the repair is presently on file with the NJDEP for Dam Permit #222.

On June 6, 1937, the dam structure failed in the vicinity of the junction of the right abutment and right end of the gate structure thereby causing failure of the right side banks. The necessary repairs were made in accordance with drawings entitled, "Proposed Repair of Smithville Dam," dated July 1937 prepared by a Mr. Willets of the H.B. Smith Machine Co. Mr. G.W. Branin of Vincentown was contracted to complete the proposed work. The H.B. Smith Machine Co. was informed in July, 1937, by the New Jersey State Water Policy Commission (NJSWPC) that the proposed repairs, as shown on the above noted drawings had been approved as additional work under Dam Permit #222 issued September 13, 1933. An NJSWPC inspection of September 22, 1937 revealed that the repair had proved unsuccessful due to the insufficient length of the sheet piling.

In 1938, the Federal Government approved a grant under the auspices of the WPA for the construction of a new dam at Smithville. Plans entitled, "Plans for Smithville Dam," dated February 1939 were then prepared by Mr. E.K. Bryant, Engineer, Township of Eastampton. The plans were approved and Dam Permit #329 was issued March 8, 1939 to begin construction. Construction began on February 2, 1940 and was completed on December 8, 1941. Reportedly, during construction of the new dam continual erosion of the right side bank resulted in several field construction revisions.

Reportedly, in 1953, the dam again failed. Designs were then prepared and supervised by the Bureau of Navigation. Plans entitled "Plan of Proposed Repairs to Existing Smithville Dam," dated September 1953 were approved on October 1, 1953 together with a set of specifications. Construction was completed on September 23, 1954 under Dam Permit #427 as approved by the NJSWPC.

On July 13, 1955, permission was given by the State Water Policy and Supply Council to install head gates to raise the water level. These gates would be closed from April 15 to October 15 annually. Plans were approved October 1953. A paid dam keeper was reportedly employed by the Township of Eastampton on June 29, 1955.

Reportedly, in June 1957, a leak was observed through the old creosoted sheet piling at the right end of the spillway. A considerable amount of soil had washed out. It is not known if any action was taken to repair the washout and leakage.

On November 16, 1965, the Township of Eastampton by way of letter from the Township Engineer requested that an inspection of the dam be made by the New Jersey Division of Water Policy and Supply. The inspection performed on December 3, 1965 revealed that 8 of the 12 flood gates were inoperable due to broken or missing cables, but structurally the dam was assessed as being in fairly good condition. It was also observed that the timber bulkhead on both the north and south bank immediately downstream from the spillway were found to be in poor and deteriorated condition. The Township of Eastampton was then ordered by the New Jersey Division of Water Policy and Supply to immediately take the necessary action to repair the dam completely. Reportedly, it was the opinion of the NJDWPS that if the flood gates had been properly maintained the damage to the embankments would not have occurred. The Town then began

to search for possible funds. The gates were ordered to be maintained in an open position by March 25, 1968 by order of the NJDWPS due to additional damage sustained by flooding and ice movement.

On December 12, 1969, repair drawings by Richard A. Alaimo Associates dated October 1968, entitled "Proposed Bulkhead Replacement" were approved under Dam Permit #472. Construction began in April 1969 which consisted of the removal of twelve old gates and their replacement with new timber gates. Steel sheet pilings were driven to function as bulkhead along the banks of the creek in the area close to the gates. It is not known when this construction was completed.

In 1980, the twelve timber slide gates were removed and replaced with wheel-operated aluminum slide gates by the County of Burlington. The new gates were installed in accordance with specifications and plans entitled, "Replacement of Flood gates - Smithville Dam," dated February 11, 1980, prepared by the Burlington County Engineering Department. These plans are on file with the Burlington County Engineering Department.

#### G. Normal Operation Procedure

Maintenance of Smithville Dam reportedly is performed by the Burlington County Highway Department. Reportedly, normal repairs consist of replacement of rotted timbers and cleaning of debris.

Reportedly, the North Branch of the Rancocas Creek is maintained at its normal stream level during the winter months, between November and April, when the flood gates are completely opened. The floodgates are closed during the summer months when the impoundment and nearby lake are used for recreation.

### 1.3 Pertinent Data

|    |                                 |                           |
|----|---------------------------------|---------------------------|
| a. | Drainage Area                   | 132 square miles          |
| b. | Maximum flood at damsite        | 1450 cfs (September 1938) |
|    | Outlet works at pool elevation  | N.A.                      |
|    | Spillway capacity at top of dam | 1062 cfs                  |
| c. | Elevation (N.G.V.D.)            |                           |
|    | Top of dam                      | 22.0                      |
|    | Maximum pool-design surcharge   | 26.2                      |
|    | Primary spillway crest          | 18.6                      |
|    | Stream bed at toe of dam        | 12.0                      |
|    | Maximum tailwater               | 26 (Estimated)            |
| d. | Reservoir                       |                           |
|    | Length of maximum pool          | N.A.                      |
|    | Length of recreation pool       | N.A.                      |
| e. | Storage (Acre-feet)             |                           |
|    | Recreation pool                 | 65                        |
|    | Design surcharge                | 649                       |
|    | Top of dam                      | 244                       |
| f. | Reservoir Surface (acres)       |                           |
|    | Top of dam                      | 83 (Estimated)            |
|    | Maximum pool - design surcharge | 116 (Estimated)           |
|    | Recreation pool                 | 36.7                      |

g. Dam

|                       |                       |
|-----------------------|-----------------------|
| Type                  | Timber frame and pile |
| Length                | 60 feet               |
| Height                | 10.0 feet             |
| Sideslopes - Upstream | N.A.                  |
| - Downstream          | N.A.                  |
| Zoning                | N.A.                  |
| Impervious core       | N.A.                  |
| Cutoff                | Unknown               |
| Grout curtain         | Unknown               |

h. Diversion and Regulating Tunnel N.A.

i. Spillway

|                         |                                            |
|-------------------------|--------------------------------------------|
| Type                    | Sharp-Crested Weir                         |
| Length of primary weir  | 51 feet                                    |
| Primary crest elevation | 18.6                                       |
| Gates                   | Metal Slide Gates Comprise<br>Primary Weir |
| Upstream channel        | Natural Stream                             |
| Downstream channel      | Natural Stream                             |

j. Regulating Outlet

Twelve (12) wheel operated metal slide gates.

## SECTION 2: ENGINEERING DATA

### 2.1 Design

No plans or calculations pertaining to the original construction of the dam could be obtained. Information relating to the 1934, 1937, 1953, 1955, 1957 and 1969 repairs and reconstructions of the dam are available in the files of the NJDEP. Information relating to the installation of the new flood gates in 1980 are on file with the Burlington County Engineering Department.

The dam reconstructed in 1941 was based upon a design capacity of 1012 cfs at the top of the dam, the same design capacity as the old dam built in 1934 and also the same design capacity as Mill Dam, located downstream at Mt. Holly. According to the information available in the NJDEP files since both Mill Dam and Smithville Dam are inundated by tailwater during maximum flood flows, it was decided to use the 1934 design. It was thought a spillway of greater capacity would increase the possibility of flood damage downstream at Mt. Holly.

### 2.2 Construction

No data or reports pertaining to the original construction of the dam are available. Numerous inspection reports are on file with the NJDEP with exception of the repair performed in 1957 and the most recent renovations of 1968 and 1980.

### 2.3 Operation

Reportedly, no maintenance reports are on file with the County of Burlington. No data pertaining to operations are available.

## 2.4 Evaluation

### a. Availability

Available engineering data is limited to that which is on file with the NJDEP, Division of Water Resources and the Burlington County Engineering Department. These files contain drawings, correspondence, hydraulic and hydrologic calculations, inspection reports, samples of test borings, applications and permits relating to the various repairs and reconstructions.

### b. Adequacy

Available engineering data pertaining to Smithville Dam is of significant assistance to the performance of a Phase I evaluation. A list of absent information is included in paragraph 7.1.b.

### c. Validity

The available hydraulic analyses appear to be valid with respect to engineering practice generally accepted in 1941. However, they are not valid according to analytic procedures developed by the Corps of Engineers for the present inspection and assessment program.

Although spillway discharge rates are in close agreement with values computed in connection with this Phase I Report, the design flood used in 1953 is not in conformance with the presently utilized SDF.

Hydraulic and hydrologic calculations indicate that during a storm equivalent to the SDF, Smithville Dam would be submerged by tailwater. Furthermore, the dam has very little flood attenuation effect during severe storm events. Therefore, increasing spillway capacity may not increase the possibility of flood damage downstream at Mt. Holly as assumed during previous design analyses.

## SECTION 3: VISUAL INSPECTION

### 3.1 Findings

#### a. General

The inspection of Smithville Dam was performed on January 6, 1981 by staff members of Storch Engineers. A copy of the visual inspection check list is contained in Appendix 1. The following procedures were employed for the inspection:

- 1) The embankment of the dam, appurtenant structures and adjacent areas were examined.
- 2) The embankment and accessible appurtenant structures were measured and key elevations determined by surveyor's level.
- 3) The embankment, appurtenant structures and adjacent areas were photographed.
- 4) The downstream flood plain was toured to evaluate downstream development and restricting structures.

#### b. Dam

At the time of inspection one of the slide gates was in its "up" position and the river was discharging through that one gate.

The downstream apron appeared to be concrete with timber piles at its downstream end on which the timber frames rest. The timbers bracing the frames for the gates and the walkways appeared to be sound and in generally satisfactory condition. They have all been treated for rot.

The steel sheet pilings along the right side of the river were significantly rusted with scales peeling off. However, they appeared to be generally sound. The steel cap along the top

of the sheet piling along both sides of the dam was in satisfactory condition. The steel sheet pilings on the left side of the dam appeared to be in satisfactory condition. The steel wales on both sides were rusted and in deteriorated condition.

c. Appurtenant Structures

The river bank downstream from the dam was stabilized on both sides by riprap composed of concrete. The left concrete stabilization appeared to be undermined. Further down on the right side, large pieces of concrete were serving as riprap. In general the stabilization did not appear to be to be satisfactory and should be renovated. The banks of the river upstream from the dam were not stabilized and the right bank showed evidence of erosion. There was a chain link fence at both ends of the dam apparently to prevent trespassing. The fence appeared to be relatively recent and in satisfactory condition. Barbed wires at the ends of the fence that protrude over the river have been cut. A flood light atop a telephone pole at the right end of the dam, which appeared to be a mercury vapor type of flood light, serves to illuminate the dam at night. Reportedly, the light is activated every day by photo cell.

The junction between the steel sheet piling on the right side of the dam and the concrete bank stabilization appeared to be generally sound.

Concrete surface drain swales adjacent to the steel sheet pile abutments appeared to be in satisfactory condition.

c. Reservoir Area

The reservoir area is formed by the upstream portion of the North Branch of the Rancocas Creek impounded by the dam. It has banks similar to that of the downstream section. The

reservoir (stream) shores are wooded with banks approximately two feet high. The reservoir area then extends on a broad flat floodplain approximately 200 feet wide on the left side and approximately 400 feet wide on the right side. A machine shop situated in an old brick building is located immediately upstream of the dam on the left shore. The first floor elevation is approximately three feet above the water level at the time of inspection.

d. Downstream Channel

The downstream channel is a shallow, meandering river called the North Branch of the Rancocas Creek. It makes a sharp bend to the right about 200 feet downstream from the dam. It has banks approximately three to four feet high and wooded terrain on each side, comprising the floodplain, which extends approximately 200 feet to the left and 400 feet to the right.

There is a small white house approximately 300 to 400 feet downstream from the dam on the left side of the river in the area where the river makes its right hand bend. Further downstream, within one mile of the dam, several dwellings are located along the stream. Approximately two miles downstream, Mill Dam and the Township of Mt. Holly are located.

## SECTION 4: OPERATIONAL PROCEDURES

### 4.1 Procedures

The level of water in Rancocas Creek is regulated by discharge through the twelve gates which span the river forming Smithville Dam. The gates can be used to lower the river level or to augment the discharge capacity of the spillway. Normally the gates are opened during the winter months in an attempt to prevent ice damage and are closed during the summer for recreational purposes. However, as a result of the drought during the past two years, all of the gates have been maintained in a closed position except during periods of heavy rain when the gates are opened at the direction of the Burlington County Civil Defense Coordinator.

### 4.2 Maintenance of the Dam

Reportedly, the dam is maintained on an "as needed" basis by the Burlington County Highway Department.

### 4.3 Maintenance of Operating Facilities

Reportedly, the operating facilities are inspected on a daily basis by the Burlington County Civil Defense Coordinator or his designee who in turn directs the Burlington County Highway Department to perform any necessary repairs including the cleaning of debris. Reportedly, during the past ten years the spillway gates have been the object of frequent vandalism. Therefore, a chainlink fence was installed for protection. In addition, a photoelectric floodlight has been installed to deter vandalism and is used during night time debris cleaning and gate maintenance operations.

#### 4.4 Description of Warning and Operational System

Reportedly an informal but effective warning system is in effect along the entire length of the North Branch of the Rancocas Creek under the auspices of the Burlington County Civil Defense Coordinator. The participating communities include the Township of Mt. Holly (Mill Dam), Eastampton Township (Smithville Dam), Pemberton Boro (Spill Dam), and Pemberton Township (Mirror Lake Dam). During periods of heavy rain the level of water in the North Branch of the Rancocas Creek is monitored visually by the Burlington County Civil Defense which coordinates the work forces necessary to augment and diminish the discharge capacities at the respective dams including Smithville Dam.

Reportedly, the Burlington County Civil Defense monitors the weather by radio during periods of expected precipitation on a 24-hour basis. Reportedly, the spillway gates are opened on a staggered basis, beginning with most downstream dam (Mt. Holly-Mill Dam) and then proceeding upstream at time intervals determined by the Burlington County Civil Defense. Normally, the gates are opened when the chance of rain is forecast between 50 and 100 percent. As the possibility for the chance of rain decreases the gates are closed unless visual reports necessitate other action. As a safety precaution no worker is permitted to operate the metal outlet mechanisms during periods of lightning or thunder.

Reportedly, the warning system and procedures outlined above has proven through experience to be the most effective system proposed to date.

#### 4.5 Evaluation of Operational Adequacy

The operation of the dam has not been successful to the extent that the dam reportedly has overtopped two to three times yearly prior to 1978 resulting in the inundation of several summer dwellings

located downstream. Reportedly, since 1978, the beginning of the drought, the dam has not overtopped. Reportedly, when overtopping occurs it is actually the tailwater rising to an elevation higher than the top of dam, this being caused by the inadequacy of the downstream channel.

Although maintenance has been good in some areas, some aspects of dam maintenance have not been satisfactorily performed, including the following:

- 1) The steel sheet pilings along the right side of the river are significantly rusted with scales peeling off and have not been maintained.
- 2) The right river bank downstream from the dam is eroding and should be stabilized. The left bank appears to be undermined and should be stabilized.

## SECTION 5: HYDRAULIC/HYDROLOGIC

### 5.1 Evaluation of Features

#### a. Design Data

The quantity of storm water runoff that the spillway should be able to handle is based on the size and hazard classification of the dam. This runoff quantity, called the spillway design flood (SDF) is described in terms of return frequency or probable maximum flood (PMF) depending on the extent of the dam's size and potential hazard. According to the "Recommended Guidelines for Safety Inspection of Dams " published by the U.S. Army Corps of Engineers, the SDF for Smithville Dam falls in a range of 1/2 PMF to PMF. In this case, the lower end of the range, 1/2 PMF, is chosen since the factors used to select size and hazard classification are on the low side of their respective ranges.

The inflow hydrograph for the Smithville Dam impoundment was calculated using Clark's Method with a synthetic time-area curve. General hydrologic characteristics such as: Drainage Area (DA), Surface Storage Index ( $S_t$ ), Main Channel Slope (S) and Man-made Impervious Cover Index (I) were computed using USGS quadrangles. These data were used in conjunction with the following equations to determine the Clark's Method Parameters (R and  $T_c$ ):

$$T_c + R = 21.0 (DA/S)^{0.22} (ST)^{0.33} (1.0 + 0.3(I))^{-0.28}$$

$$T_c = 6.82 (DA/S)^{0.17} (ST)^{0.41} (1.0 + 0.3 (I))^{-0.42}$$

The total drainage area contributing to Smithville Dam is 132 square miles. Most of the watershed is undeveloped woodland, swamp and cranberry bogs. There are four moderately sized population centers in the watershed: Fort Dix Military Reservation, Pemberton, Vincetown and Browns Mills. The SDF peak computed for the dam is 13,592 c.f.s.

Reservoir storage capacities were estimated using surface areas measured from USGS quadrangles. Discharge hydraulics for the spillway facilities were computed by considering the slide gates as sharp-crested weirs (See Appendix 4). The spillway discharge with lake level equal to the top of dam was computed to be 1,062 c.f.s. It should be noted that the spillway discharge capacity as indicated in the NJDEP files was 1012 c.f.s. The SDF was routed through the dam by use of the HEC-1-DAM computer program using the modified Puls Method. In routing the SDF, it was found that the dam crest would be overtopped by a depth of 4.2 feet. The analysis indicated that failure of the dam would not significantly increase the potential for loss of life over that which would exist without failure. Accordingly, the subject spillway is assessed as being inadequate in accordance with criteria developed by the U.S. Army Corps of Engineers.

b. Experience Data

Reportedly, the dam has not been overtopped since the drought began in 1978. However, prior to 1978, the dam was overtopped two or three times a year as noted previously in this report resulting in the inundation of several summer dwellings located downstream. .

Also, a note accompanying Dam Application No. 329, dated January 31, 1939 stated: "Since discharge capacity of proposed new gates equals that of existing gates at Mount Holly water works dam, downstream, and since both dams are flooded out by back water under maximum flood flows, approval is recommended. Discharge capacity of proposed gates is also same as that of old dam at Smithville which is replaced by the proposed dam."

c. Visual Observation

No evidence was found at the time of inspection that would indicate that the dam had been overtopped in recent years.

d. Overtopping Potential

As indicated in paragraph 5.1.a, a storm of magnitude equal to the SDF would cause overtopping of the dam by a depth of 4.2 feet over the crest of the dam. The spillway is capable of passing approximately 8 percent of the SDF with lake level equal to the top of dam.

## SECTION 6: STRUCTURAL STABILITY

### 6.1 Evaluation of Structural Stability

#### a. Visual Observations

The dam appeared, at the time of inspection to be outwardly structurally sound with no evidence of unusual movement or distress.

#### b. Generalized Soils Description

The soils at Smithville Dam site are characterized by the alluvial deposits surrounding the lake. In the northern area, the alluvium is intermingled with soils of marine origin. In the southern area, alluvium composed mainly of silt and sand are found adjacent to the present stream courses.

The formation underlying the dam structure is the Mount Laurel and Wenonah Sands, as identified on the Geologic Map of New Jersey.

#### c. Design and Construction Data

The analysis of structural stability and construction data for the dam are not available. It should be noted, however, that correspondence and inspection reports which address the structural integrity of the dam were found in the NJDEP file and are as follows:

In a letter dated December 1, 1936, (Dam Permit File #222) the New Jersey State Water Policy Commission stated the following:

"We have examined this log (of a test hole) and are of the opinion that it would be unsafe to attempt to place the footing of a dam on top of the clay stratum encountered at a depth of

15 feet below the ground surface. This clay stratum is but 4 feet thick and is underlain by 35 feet of water-bearing quicksand.

We recommend the use of interlocking steel sheet piling about 60 feet long and continuous beneath all new structures to form a cut-off in the water-bearing quicksand by penetrating into the thick clay bed which underlies the quicksand."

A repair, following the June 6, 1936 blowout of the dam, included the driving of sheet piling to depths of 4 to 5 feet but this was temporary in nature and failed.

It should be noted that in an interoffice memo dated October 16, 1968 (Dam Permit File #472 - concerning the 1969 repairs) the following was stated:

"By studying the history of subject dam, I have discerned that the dam needed repairs twice within a span of twenty years.

Each time the repairs were made, they were identical to those proposed now.

Repairs were made in 1941, and repairs were made in 1954, and required repairs again at the estimated cost of \$48,000.00 in 1965.

Under the circumstances, there would be no justification to grant approval for repairs without making a pointed reference to all concerned."

Information taken from the NJDEP Dam Permit File #329, gives a sample of test boring as submitted by Township Engineer, Edward K. Bryant, in 1939, and is as follows:

Sample of Test Borings at Site of New Smithville Dam

| <u>Depth(ft.)</u> | <u>Description</u>                                                                               |                 |
|-------------------|--------------------------------------------------------------------------------------------------|-----------------|
| 0-5               | Dark brown clayey sand with plant roots                                                          | } Post Cape May |
| 5-6               | Slightly clayey, glauconitic, fine grained sand                                                  |                 |
| 8-11              | Typical coarse grained brown sand, and small pebbles of Cape May Formation                       |                 |
| 11-18             | Dark gray, glauconitic, micaceous, and clayey fine grained sand a relatively impermeable stratum |                 |
| 18-31             | Slightly clayey, fine-trained glauconitic and micaceous sand                                     |                 |
| 31-40             | Fine-grained, gray highly glauconitic sand                                                       |                 |
| 40-65             | Gray micaceous, glauconitic and clayey sand.<br>Mt. Laurel Wenonah formation                     |                 |

Another test boring shown on the plan entitled "Proposed Repairs at Smithville Dam" dated July 10, 1967 prepared by M. Paul Austin Engr. Assoc. Inc. shows water-bearing black sandy clay beginning at a depth of 18 feet.

d. Operating Records

No operating records are available for the dam. The water level of the North Branch of the Rancocas Creek is visually monitored by the Burlington County Civil Defense.

e. Post-Construction Changes

It appears that the substructure of the dam as it exists today was constructed in accordance with plans prepared by the

Bureau of Navigation entitled "Plan of Proposed Repairs to Existing Smithville Dam," dated September 1953 and completed in 1954.

Modifications since that repair include the installation of hand gates in 1955, the repair of leakage through the old creosoted sheet piling at the right end of the spillway around 1957, and the replacement of the bulkhead and timber gates in accordance with plans prepared by Richard A. Alaimo Associates, entitled "Proposed Bulkhead Replacement, dated October 1968."

The most recent modification to the dam occurred in 1980 when the twelve timber slide gates were removed and replaced with wheel-operated metal slide gates by the County of Burlington. Throughout all repairs, reconstructions, and modifications to the dam the original design concept of twelve slide gates as proposed in 1934 has remained intact.

f. Seismic Stability

Smithville Dam is located in Seismic Zone 1 as defined in "Recommended Guidelines for Safety Inspection of Dams" which is a zone of very low seismic activity. Experience indicates that dams in Seismic Zone 1 will have adequate stability under seismic loading conditions if they have adequate stability under static loading conditions. Smithville Dam appeared to be stable under static loading conditions at the time of inspection.

## SECTION 7: ASSESSMENT AND RECOMMENDATIONS

### 7.1 Dam Assessment

#### a. Safety

Based on hydraulic and hydrologic analyses outlined in Section 5 and Appendix 4, the spillway of Smithville Dam is assessed as being inadequate. The spillway is not able to pass the SDF without an overtopping of the dam.

The dam appeared, at the time of inspection, to be outwardly structurally stable.

#### b. Adequacy of Information

Information sources for this report include 1) field inspection, 2) USGS quadrangle, 3) various plans for repairs of Smithville Dam prepared by various engineers and agencies, 4) correspondence, inspection reports and other information contained in the files of the NJDEP, and 5) consultation with Highway Dept, Engineering Dept. and Civil Defense personnel of the County of Burlington. The information obtained is sufficient to allow a Phase I assessment as outlined in "Recommended Guidelines for Safety Inspection of Dams."

Some of the absent data are as follows:

- 1) Design computations and reports.
- 2) Maintenance documentation.

#### c. Necessity for Additional Data/Evaluation

Although some data pertaining to Smithville Dam are not available, additional data are not considered imperative for this Phase I evaluation.

## 7.2 Recommendations

### a. Remedial Measures

Based on hydraulic and hydrologic analyses outlined in paragraph 5.1.a, the spillway is considered to be inadequate. However, more detailed hydraulic and hydrologic studies are recommended only in connection with studies of other dams in the same drainage system and with structural stability investigations outlined below.

In light of past failures of the dam and the recommendation in 1936 to drive significantly longer steel sheet piling, the structural stability of the dam should be investigated in the future by a professional engineer experienced in the design and construction of dams. The investigation should include consideration of the effects of overtopping during the SDF on the stability of the dam and adjacent stream banks. As a result of the investigation, the need for and type of remedial measures should be determined and then implemented.

The owner should continue to employ the surveillance and emergency action plan currently in use. In the future, the plan should be reviewed and, after any necessary revisions, incorporated into a formal written plan.

In addition, it is recommended that the following remedial measures be undertaken in the near future:

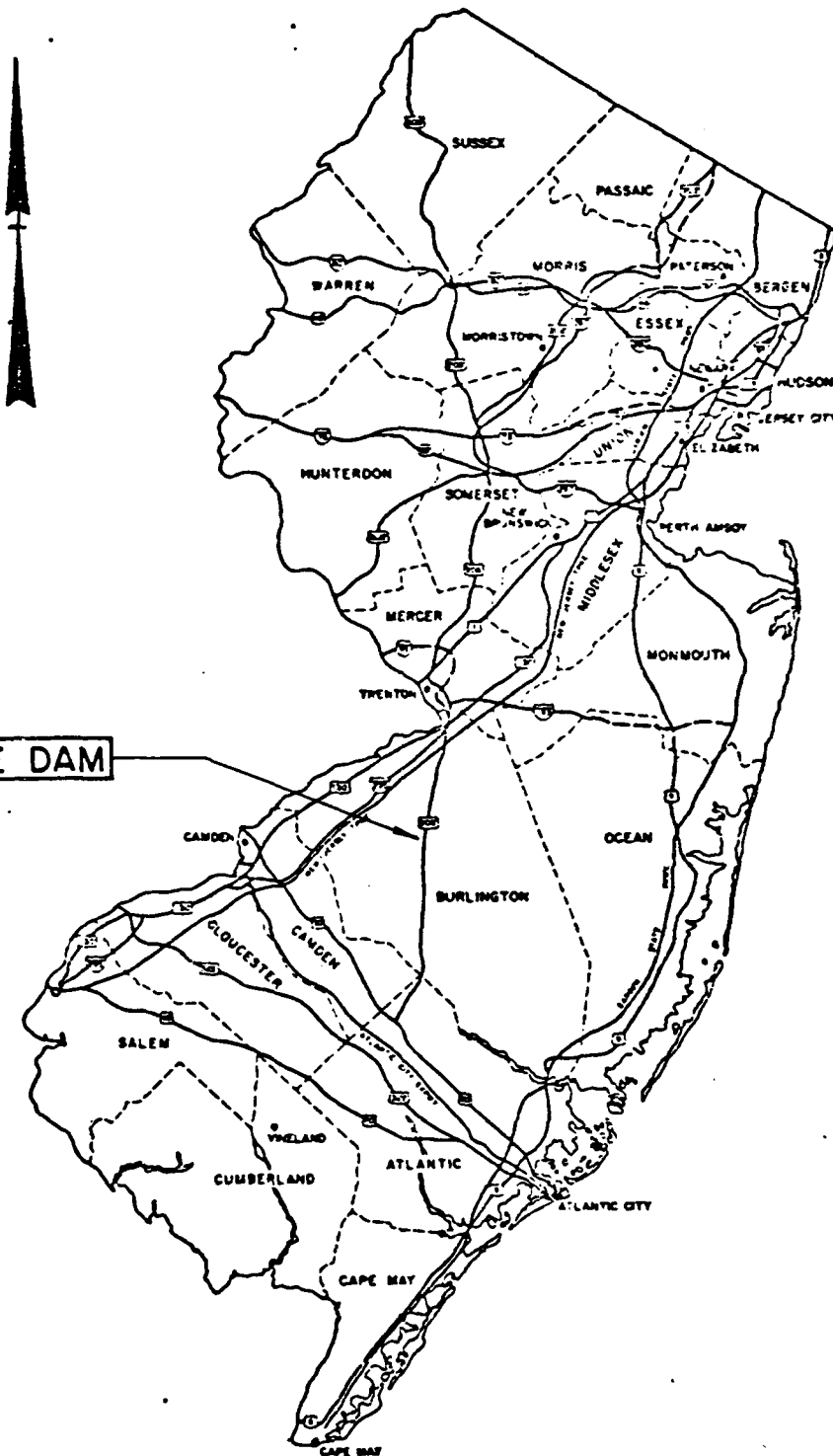
- 1) The steel sheet piling abutments at each end of the dam should be renovated by cleaning, painting and replacement of the wales.
- 2) The stabilization of the stream banks downstream from the dam should be renovated.

b. Maintenance

In the future, the owner of the dam should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

PLATES

**SMITHVILLE DAM**



**PLATE I**

**STORCH ENGINEERS**  
FLORHAM PARK, NEW JERSEY

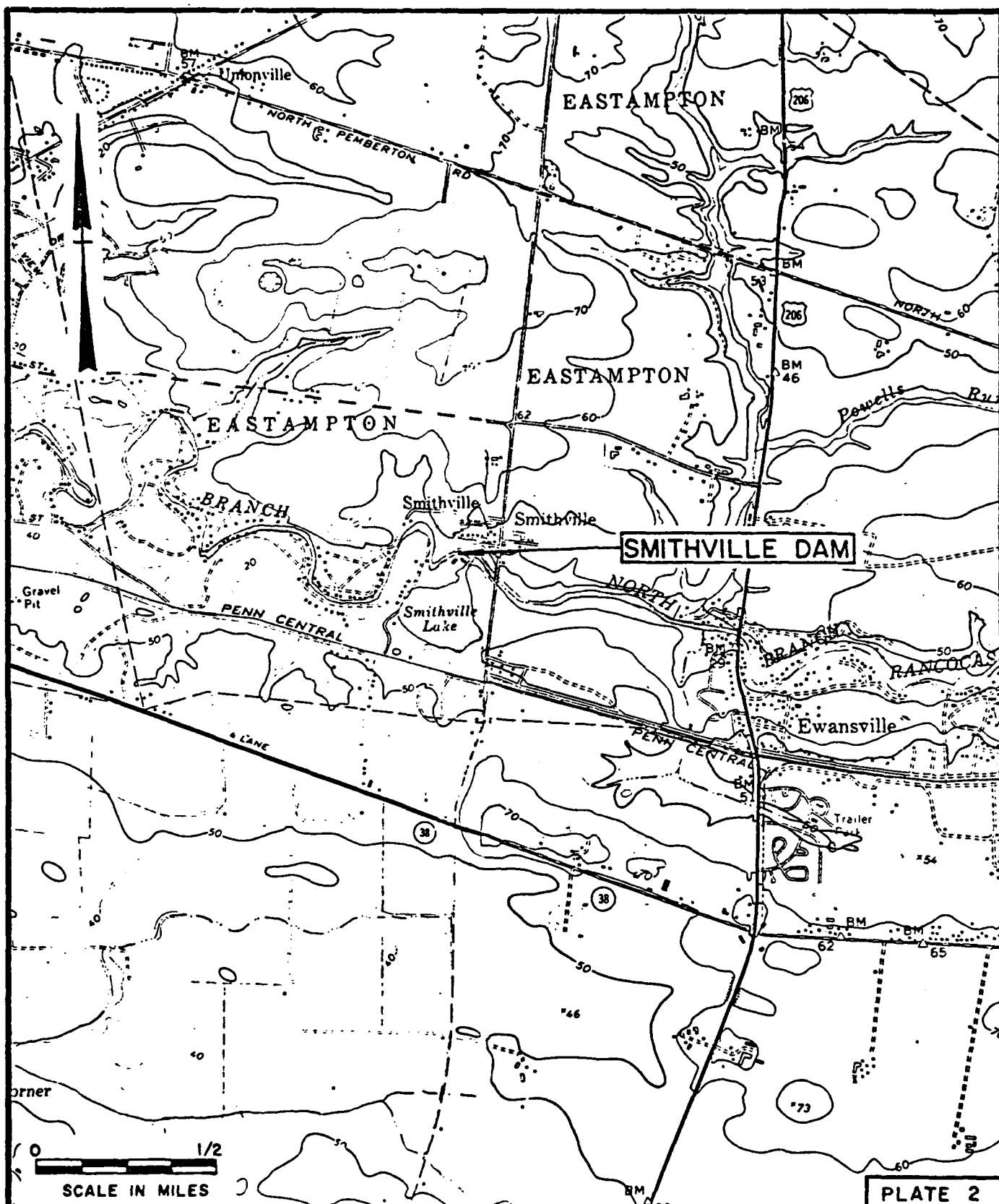
**INSPECTION AND EVALUATION OF DAMS**  
**KEY MAP**

**SMITHVILLE DAM**

**DIVISION OF WATER RESOURCES**  
**N.J. DEPT. OF ENVIR. PROTECTION**  
TRENTON, NEW JERSEY

**SCALE: NONE**

**DATE: FEB. 1981**



STORCH ENGINEERS  
FLORHAM PARK, NEW JERSEY

DIVISION OF WATER RESOURCES  
N.J. DEPT. OF ENVIR. PROTECTION  
TRENTON, NEW JERSEY

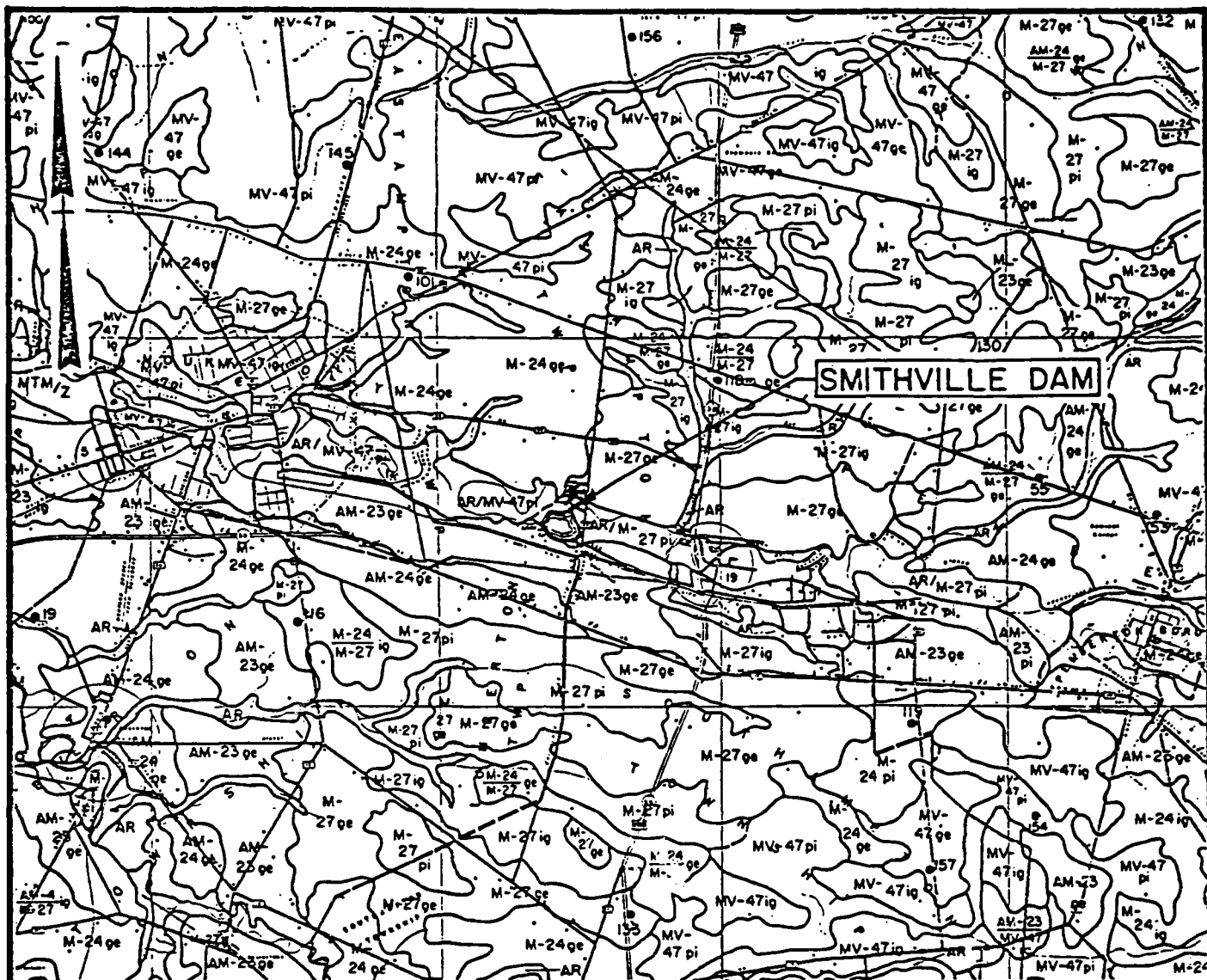
# INSPECTION AND EVALUATION OF DAMS

## VICINITY MAP

### SMITHVILLE DAM

SCALE: AS SHOWN

DATE: FEB. 1981



### Legend

- M-27 Stratified deposits of marine origin.
- AM-24 Unconsolidated, stratified alluvial deposits.
- AM-23 Irregular mantle of stratified alluvial material.
- AR Recent alluvium deposited adjacent to present stream courses.

Note: Information taken from Rutgers University, Soil Survey of New Jersey, Report No. 20, Burlington County, May 1955 and Geologic Map of New Jersey prepared by J.V. Lewis and H. Kummel 1910-1912, revised by H. B. Kummel 1931 and M. Johnson 1950.

PLATE 3

STORCH ENGINEERS  
FLORHAM PARK, NEW JERSEY.

DIVISION OF WATER RESOURCES  
N.J. DEPT. OF ENVIR. PROTECTION  
TRENTON, NEW JERSEY.

INSPECTION AND EVALUATION OF DAMS

SOIL MAP  
SMITHVILLE DAM

SCALE: NONE

DATE: FEB. 1981

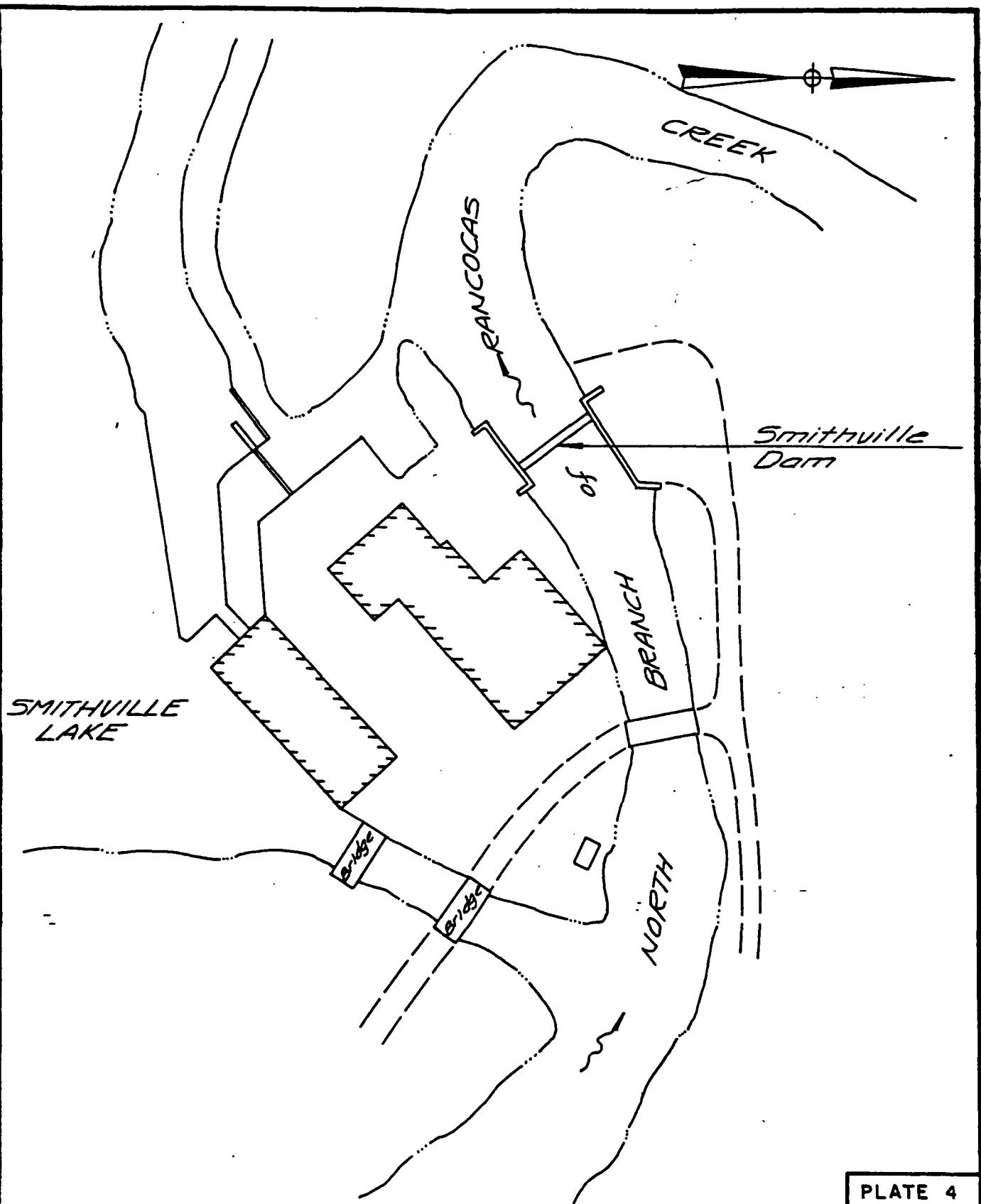


PLATE 4

STORCH ENGINEERS  
FLORHAM PARK, NEW JERSEY

DIVISION OF WATER RESOURCES  
N.J. DEPT. OF ENVIR. PROTECTION  
TRENTON, NEW JERSEY

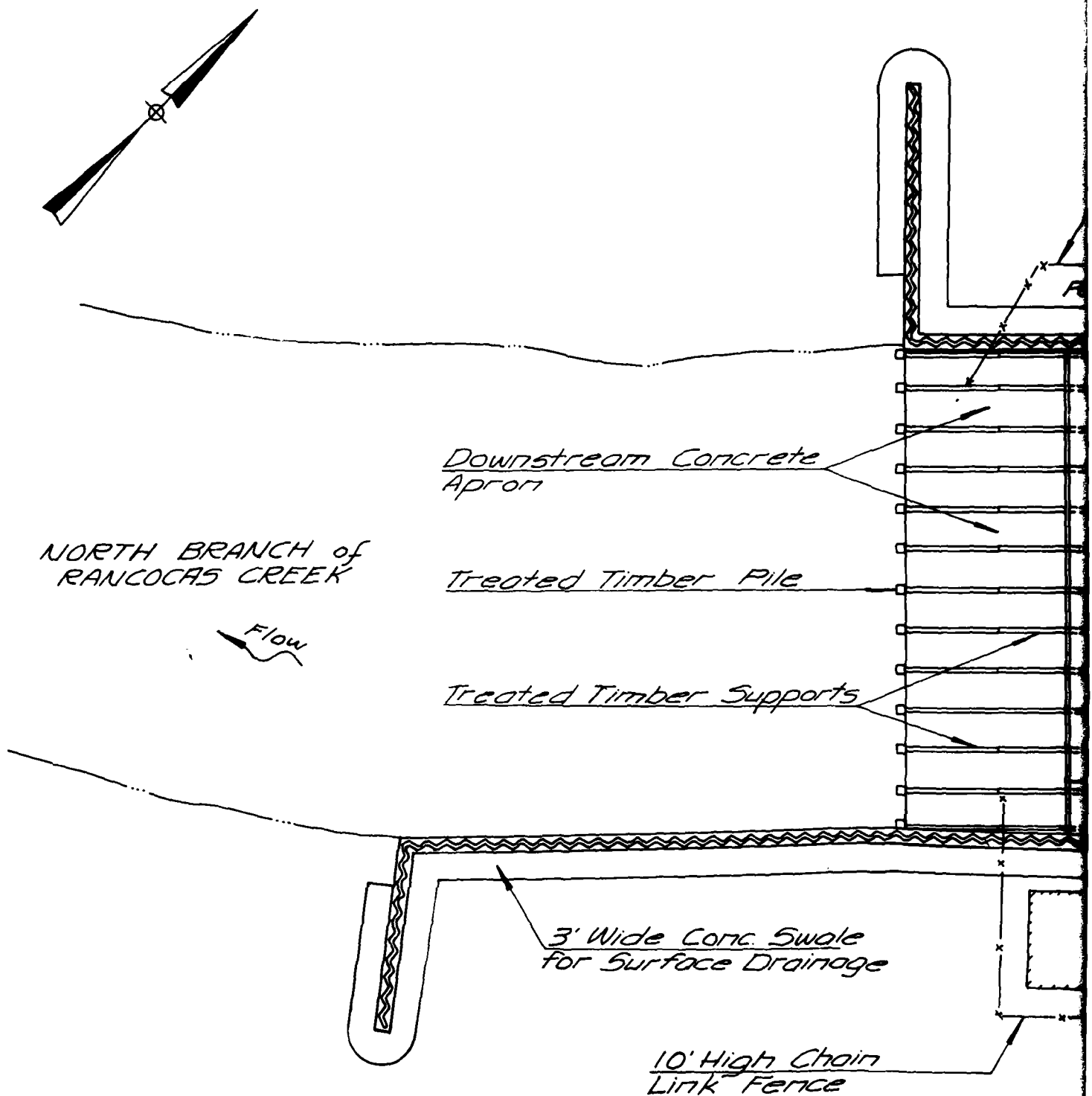
# INSPECTION AND EVALUATION OF DAMS OVERVIEW

## SMITHVILLE DAM

I.D. N.J. 00043

SCALE: NONE

DATE: APRIL, 1981



*Note:*

Information taken from:

1. "Plan of Proposed Repairs to Existing Smithville Dam" dated 9/53 prepared by Bureau of Navigation.
2. "Proposed Bulkhead Replacement - Smithville Dam" dated 12/6/68 prepared by Richard A. Alaimo Assoc.
3. "Replacement of Floodgates - Smithville Dam" dated 2/11/80 prepared by Burlington County Engineering Dept.
4. Field Inspection January 6, 1981.

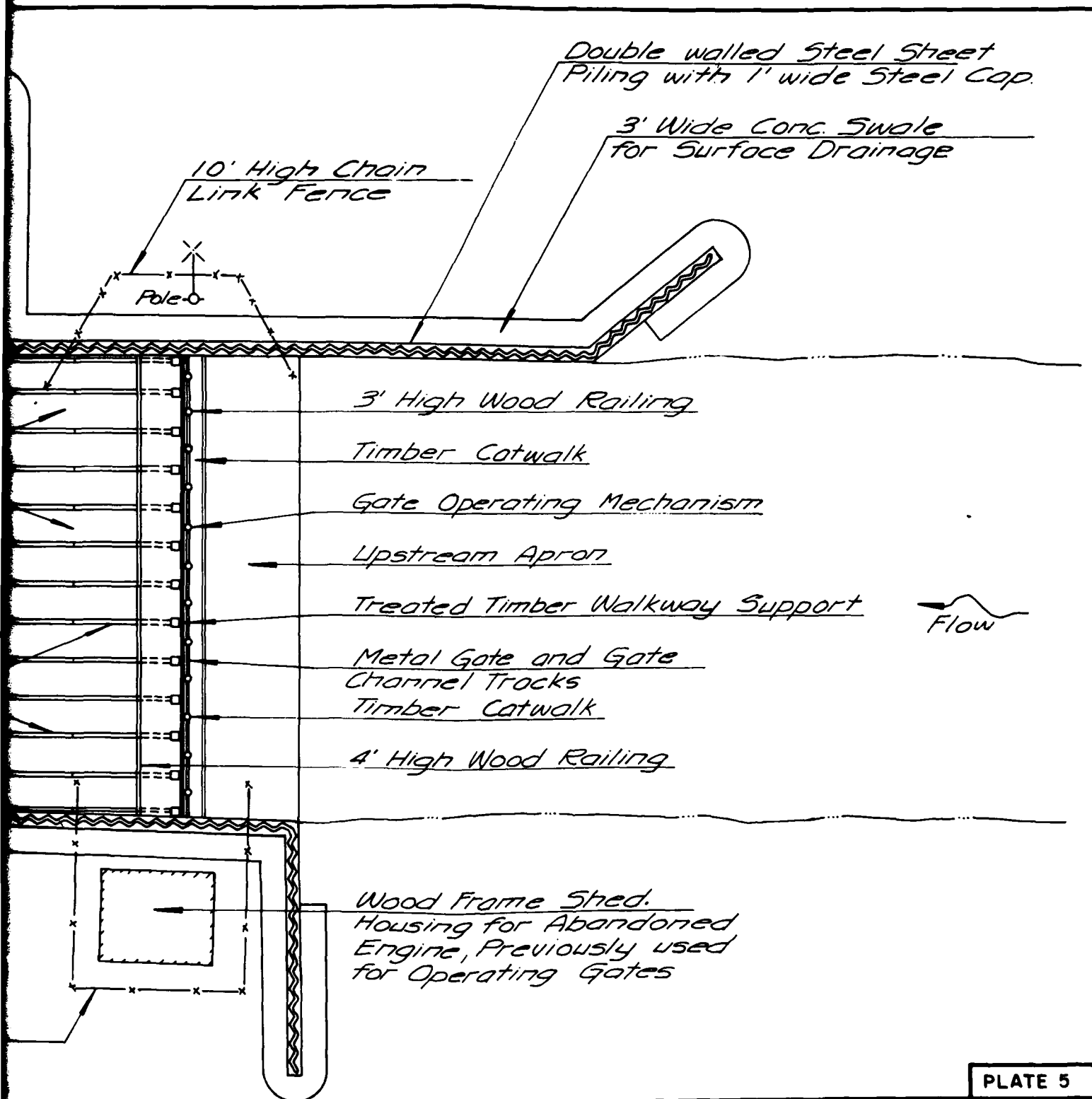


PLATE 5

STORCH ENGINEERS  
FLORHAM PARK, NEW JERSEY

DIVISION OF WATER RESOURCES  
N.J. DEPT. OF ENVIR. PROTECTION  
TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS  
GENERAL PLAN  
SMITHVILLE DAM

I.D. N.J. 00043

SCALE: NOT TO SCALE

DATE: FEB, 1981

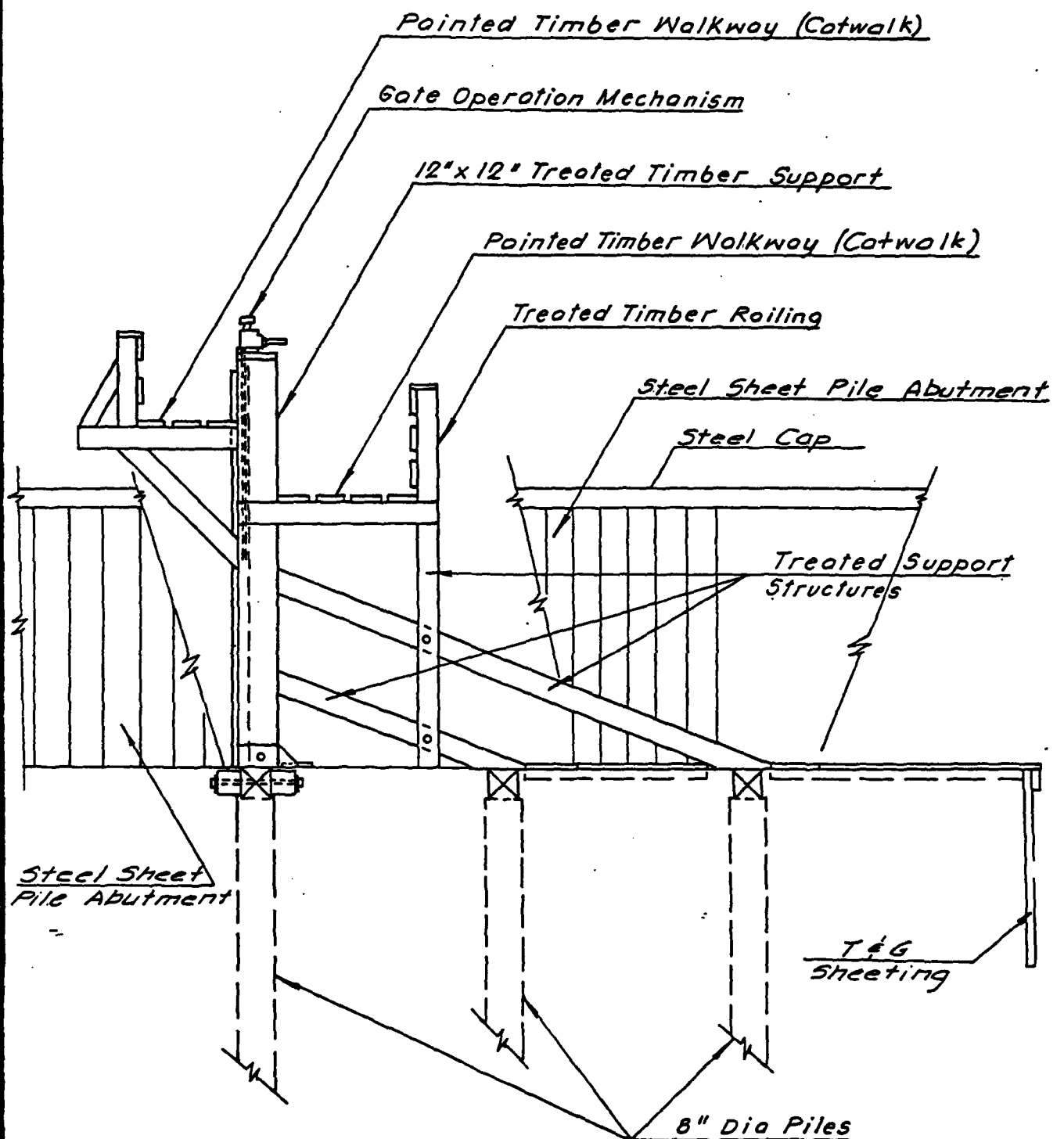


PLATE 6

STORCH ENGINEERS  
FLORHAM PARK, NEW JERSEY

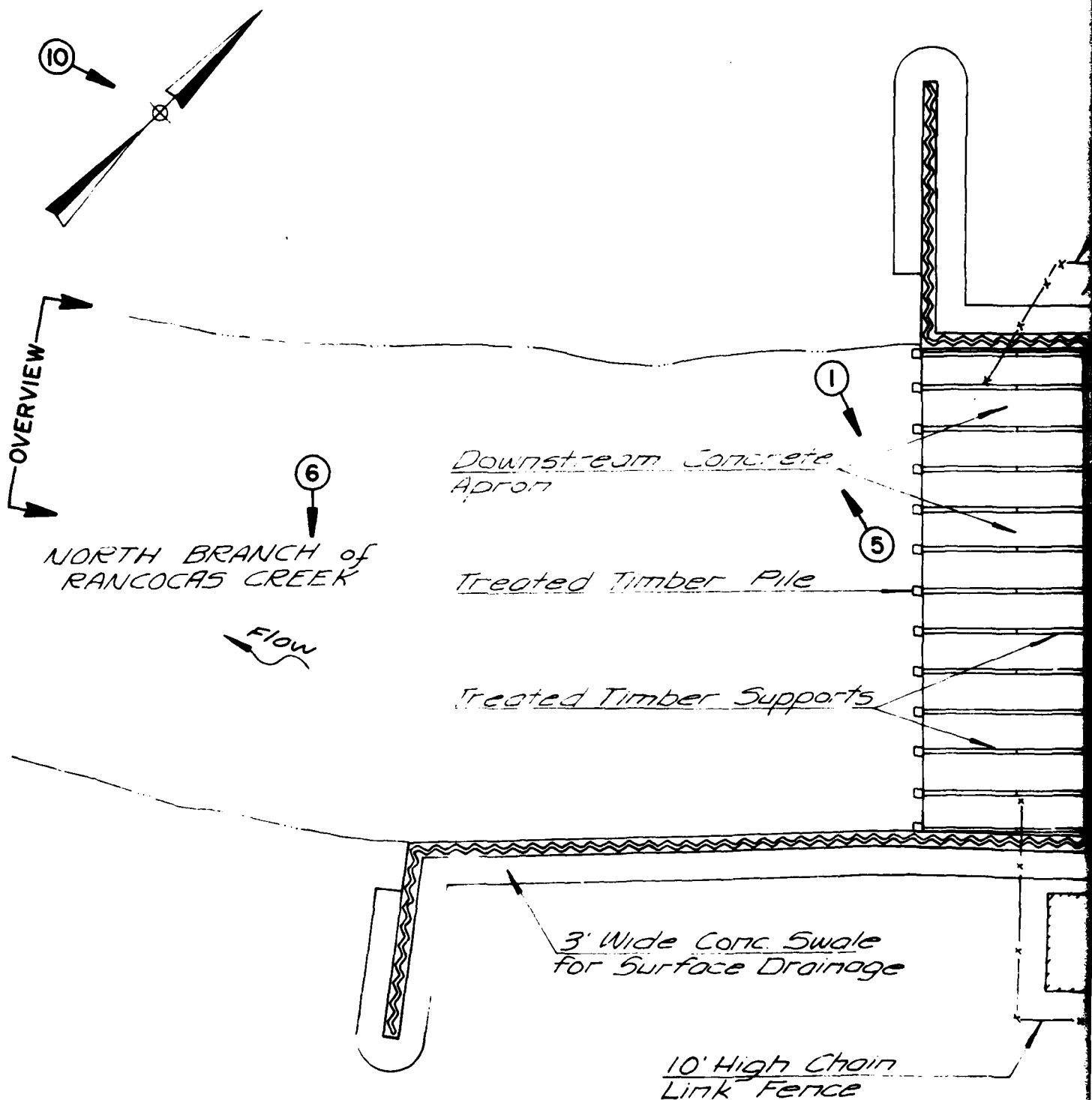
DIVISION OF WATER RESOURCES  
N.J. DEPT. OF ENVIR. PROTECTION  
TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS  
SPILLWAY SECTION  
SMITHVILLE DAM

I.D. NJ 00043

SCALE: NONE

DATE: FEB. 1981



*Note*

*Information taken from:*

1. "Plan of Proposed Repairs to Existing Smithville Dam" dated 9/53 prepared by Bureau of Navigation
2. "Proposed Bulkhead Replacement - Smithville Dam" dated 12/6/68 prepared by Richard A. Alaimo Assoc
3. "Replacement of Floodgates - Smithville Dam" dated 2/11/80 prepared by Burlington County Engineering Dept
4. Field Inspection January 6, 1981.

10' High Chain  
Link Fence

Pole

Double walled Steel Sheet  
Piling with 1' wide Steel Cap

3' Wide Conc Swale  
for Surface Drainage

3' High Wood Railing

Timber Catwalk

⑦ Gate Operating Mechanism

Upstream Apron

Treated Timber Walkway Support

Metal Gate and Gate  
Channel Tracks  
Timber Catwalk

4' High Wood Railing

Flow

Wood Frame Shed.  
Housing for Abandoned  
Engine, Previously used  
for Operating Gates

PLATE 7

STORCH ENGINEERS  
FLORHAM PARK, NEW JERSEY

DIVISION OF WATER RESOURCES  
N.J. DEPT. OF ENVIR. PROTECTION  
TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS  
PHOTO LOCATION PLAN  
SMITHVILLE DAM

I.D. N.J. 00043

SCALE: NOT TO SCALE

DATE: FEB, 1981

APPENDIX 1

Check List - Visual Inspection

Check List - Engineering Data

Check List

Visual Inspection

Phase I

Name of Dam Smithville Dam County Burlington State N.J. Coordinators NJDEP

Date(s) Inspection 1/6/81 Weather P. Cloudy Temperature 25° F.

Pool Elevation at time of Inspection 18.5 M.S.L. Tailwater at Time of Inspection 13.3 M.S.L.

Inspection Personnel:

|                        |                          |
|------------------------|--------------------------|
| <u>John Gribbin</u>    | <u>Richard McDermott</u> |
| <u>Daniel Buckelew</u> | <u></u>                  |
| <u>Mark Brady</u>      | <u></u>                  |

John Gribbin Recorder

Present: Mr. Reese Thomas, Assistant Road Supervisor, Burlington County.

# OUTLET WORKS

| VISUAL EXAMINATION OF                  | OBSERVATIONS                                                                                                | REMARKS OR RECOMMENDATIONS                                    |
|----------------------------------------|-------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|
| CONCRETE SURFACES IN<br>OUTLET CONDUIT | N.A.                                                                                                        | Outlet works consist of slide gates in<br>spillway structure. |
| INTAKE STRUCTURE                       | N.A.                                                                                                        |                                                               |
| OUTLET STRUCTURE                       | N.A.                                                                                                        |                                                               |
| OUTLET CHANNEL                         | Gates discharge directly into downstream channel.                                                           |                                                               |
| GATE AND GATE HOUSING                  | Twelve metal gates, tracks and operating mechanisms<br>appeared to be recent and in satisfactory condition. |                                                               |

# SPILLWAY

| VISUAL EXAMINATION OF | OBSERVATIONS                                                                                                                                                                                                                                        | REMARKS OR RECOMMENDATIONS                                                                                                                                                           |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| WEIR                  | Weir formed by tops of slide gates appeared to be in satisfactory condition.                                                                                                                                                                        |                                                                                                                                                                                      |
| ABUTMENTS             | Steel sheet piles appeared generally sound but rusted with rust scales peeling off. Steel cap was in satisfactory condition. Concrete surface runoff swales adjacent to abutments were in satisfactory condition. Steel wales significantly rusted. | Abutments formed by interlocking steel sheet piles driven along stream banks perpendicular to dam and keyed into banks.<br>Steel sheet piles should be cleaned and treated for rust. |
| APRON                 | Concrete and timber downstream apron appeared to be in satisfactory condition.                                                                                                                                                                      | Apron obscured by discharge at the time of inspection.                                                                                                                               |
| TIMBER BRACES         | Timber bracing appeared to be treated and in satisfactory condition.                                                                                                                                                                                |                                                                                                                                                                                      |
| CATWALKS              | Timber catwalks (upstream and downstream sides of gates) were in satisfactory condition.                                                                                                                                                            | Some planks appeared to have been replaced.                                                                                                                                          |

# INSTRUMENTATION

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|-----------------------|--------------|----------------------------|
| MONUMENTATION/SURVEYS | None         |                            |
| OBSERVATION WELLS     | None         |                            |
| WEIRS                 | None         |                            |
| PIEZOMETERS           | None         |                            |
| OTHER                 |              |                            |

# RESERVOIR

| VISUAL EXAMINATION OF  | OBSERVATIONS                                                                                                                                                                                                   | REMARKS OR RECOMMENDATIONS                                                                                                           |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| SLOPES                 | Upstream stream banks approx. 3' high at time of inspection.                                                                                                                                                   |                                                                                                                                      |
| SEDIMENTATION          | Unknown                                                                                                                                                                                                        |                                                                                                                                      |
| STRUCTURES ALONG BANKS | Old brick building located on left bank immediately upstream from dam. First floor about 3' above water level. Road bridge located about 250' upstream. Dwellings located around a portion of Smithville Lake. | Smithville Lake located adjacent to stream on which dam is located. Intake from stream to lake located about 300' upstream from dam. |

# DOWNSTREAM CHANNEL

| VISUAL EXAMINATION OF                       | OBSERVATIONS                                                                                                                                                                                                             | REMARKS OR RECOMMENDATIONS              |
|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| CONDITION<br>(OBSTRUCTION,<br>DEBRIS, ETC.) | Meandering stream (North Branch Rancocas Creek) with sharp bend to right about 200' downstream from dam.                                                                                                                 |                                         |
| SLOPES                                      | In vicinity of dam, slopes stabilized by concrete. Conc. stabilization on left bank appeared undermined. Stabilization on right bank consisted of large pieces of concrete. Stabilization appeared to be unsatisfactory. | Bank stabilization should be renovated. |
| STRUCTURES ALONG<br>BANKS                   | Several dwellings located along stream within one mile. Mill Dam and urban development of Mt. Holly located about 2 miles downstream.                                                                                    |                                         |
|                                             |                                                                                                                                                                                                                          |                                         |

CHECK LIST  
ENGINEERING DATA  
DESIGN, CONSTRUCTION, OPERATION

| ITEM                                   | REMARKS                                                                                                                                                                                     |
|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DAM - PLAN                             | "Proposed Bulkhead Replacement - Smithville Dam", dated 12/6/68 by Richard A. Alaimo Assoc. available in NJDEP Dam Permit Files, NJDEP, Division of Water Resources, Alaimo Plans - 12/6/68 |
| SPILLWAY - PLAN                        | "Plan of Proposed Repairs to Existing Smithville Dam", dated 9/53, by Bureau of Navigation available in NJDEP Dam Permit Files.                                                             |
| SECTIONS                               | Bureau of Navigation Plans - 9/53                                                                                                                                                           |
| SECTIONS                               | Bureau of Navigation Plans - 9/53                                                                                                                                                           |
| DETAILS                                | Bureau of Navigation Plans - 9/53                                                                                                                                                           |
| OPERATING EQUIPMENT<br>PLANS & DETAILS | "Replacement of Floodgates - Smithville Dam" dated 2/11/80 by Burlington County. Available at Burlington County Engineering Dept., 49 Rancocas Rd., Mt. Holly, N.J.                         |
| OUTLETS - PLAN                         | Burlington County Plans - 2/11/80                                                                                                                                                           |
| DETAILS                                | Burlington County Plans - 2/11/80                                                                                                                                                           |
| CONSTRAINTS                            | Burlington County Plans - 2/11/80                                                                                                                                                           |
| DISCHARGE RATINGS                      | 1012 c.f.s. based upon 1941 design. Same as 1934 design. Available in NJDEP Dam Permit Files.                                                                                               |
| HYDRAULIC/HYDROLOGIC DATA              | Available in NJDEP Files.                                                                                                                                                                   |
| RAINFALL/RESERVOIR RECORDS             | Not Available                                                                                                                                                                               |
| CONSTRUCTION HISTORY                   | Available in NJDEP Files                                                                                                                                                                    |
| LOCATION MAP                           | "Plan of Lots Vicinity Smithville Dam" dated 2/20/67 by M. Paul Austin Engr. Assoc. Inc. Available in NJDEP Files                                                                           |

| ITEM                             | REMARKS                                                        |
|----------------------------------|----------------------------------------------------------------|
| DESIGN REPORTS                   | Not Available                                                  |
| GEOLOGY REPORTS                  | Test Holes, Boring Logs and comments available in NJDEP Files. |
| DESIGN COMPUTATIONS              | Available in NJDEP Files                                       |
| HYDROLOGY & HYDRAULICS           | Not Available                                                  |
| DAM INSTABILITY                  | Not Available                                                  |
| SEEPAGE STUDIES                  |                                                                |
| MATERIALS INVESTIGATIONS         | Available in NJDEP Files                                       |
| BORING RECORDS                   | Not Available                                                  |
| LABORATORY                       | Available in NJDEP Files                                       |
| FIELD                            |                                                                |
| POST-CONSTRUCTION SURVEYS OF DAM | Inspection reports available in NJDEP Files                    |
| BORROW SOURCES                   | Available in NJDEP Files                                       |

| ITEM                                                  | REMARKS                                                                                                                                                    |
|-------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| MONITORING SYSTEMS                                    | Informal but reportedly effective visual inspection and warning system currently in use. Administered by Burlington County Civil Defense.                  |
| MODIFICATIONS                                         | Repairs and reconstructions of 1934, 1937, 1941, 1953, and 1969 available in NJDEP Files 1980 floodgate replacement at Burlington County Engineering Dept. |
| HIGH POOL RECORDS                                     | September 1938 - Available in NJDEP Files                                                                                                                  |
| POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS     | Not Available                                                                                                                                              |
| PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS | Available in NJDEP Files                                                                                                                                   |
| MAINTENANCE OPERATION RECORDS                         | Not Available                                                                                                                                              |

APPENDIX 2

Photographs



PHOTO 1  
DOWNSTREAM SIDE OF GATES



PHOTO 2  
UPSTREAM SIDE OF GATES

SMITHVILLE DAM  
6 JANUARY 1981



PHOTO 3  
TIMBER CATWALKS AND GATE OPERATING MECHANISMS



PHOTO 4  
TYPICAL GATE, STEM AND TRACKS

SMITHVILLE DAM  
6 JANUARY 1981



PHOTO 5  
RIGHT BANK OF CHANNEL - DOWNSTREAM



PHOTO 6  
LEFT BANK OF CHANNEL - DOWNSTREAM

SMITHVILLE DAM  
6 JANUARY 1981



PHOTO 7  
RIGHT STEEL SHEET PILE ABUTMENT



PHOTO 8  
LEFT STEEL SHEET PILE ABUTMENT

SMITHVILLE DAM  
6 JANUARY 1981

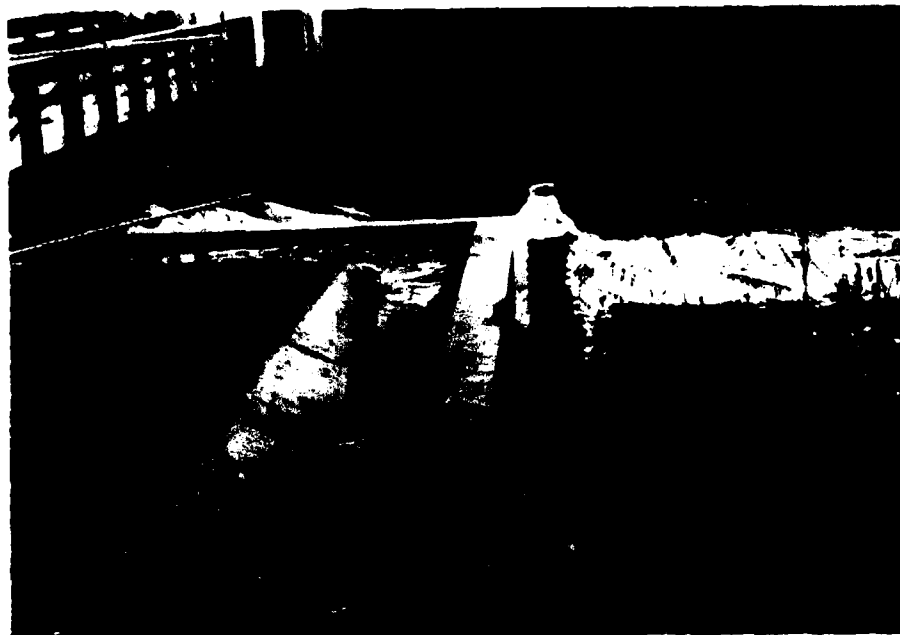


PHOTO 9  
SURFACE RUNOFF SWALE

6 JANUARY 1981



PHOTO 10  
AERIAL VIEW OF DAM SHOWING SMITHVILLE LAKE WITH INTAKE  
ABOVE DAM AND DISCHARGE BELOW DAM

31 JANUARY 1981

SMITHVILLE DAM

APPENDIX 3

Engineering Data

CHECK LIST

HYDROLOGIC AND HYDRAULIC DATA

ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Woodland, swamps and cranberry bogs.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 18.6 (65 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N.A.

ELEVATION MAXIMUM DESIGN POOL: 26.2

ELEVATION TOP DAM: 22.0

SPILLWAY CREST: \_\_\_\_\_

a. Elevation 18.6

b. Type Sharp-crested weir

c. Width N.A.

d. Length 51 feet

e. Location Spillover Tops of gates

f. Number and Type of Gates 12 metal slide gates

OUTLET WORKS: \_\_\_\_\_

a. Type Slide gates

b. Location Along full length of dam

c. Entrance Invert N.A.

d. Exit Invert 13.6

e. Emergency Draindown Facilities: Open gates

HYDROMETEOROLOGICAL GAGES: None

a. Type N.A.

b. Location N.A.

c. Records N.A.

MAXIMUM NON-DAMAGING DISCHARGE:

(Lake Stage Equal to Top of Dam) 1062 c.f.s.

APPENDIX 4

Hydraulic/Hydrologic Computations

HYDROLOGY

Unit hydrograph for Smithville Dam will be developed using Clark's parameters calculated from the following equations:

$$T_c + R = 21.0 (DA/S)^{0.22} (ST)^{0.33} (1.0 + 0.3(I))^{-0.28}$$

$$T_c = 6.82 (DA/S)^{0.17} (ST)^{0.41} (1.0 + 0.3(I))^{-0.42}$$

Supplied by the U.S. Army Corps of Engineers

where:  $I$  = % Impervious Cover

$DA$  = Drainage Area (Sq. Mi.)

$ST$  = % Storage Area (Lakes & Swamps)

$S$  = Average Channel Slope Between the Points 10 and 85 per cent of the Distance Upstream From the Outflow Point (Dam) to the Watershed Boundary. (ft./mi.)

HYDROLOGY (cont.)

1. Drainage Area = 132 SQ. MI.

2. Average Channel Slope:

Total Length = 27.2 MI.

Elevation at a distance  
of 2.72 Miles from the dam = 20 ft.

Elevation at a distance of  
23.12 Miles from the dam = 120 ft.

Average Channel Slope =  $\frac{120-20}{23.12-2.72}$

= 4.90 ft./mi.

3. Storage Area = 11.5 SQ. MI.

ST =  $\frac{11.5}{132} \times 100 = 8.7 \%$

4. Population:

Total = 56,800

Population Density =  $\frac{56,800}{132} = 430 \text{ PERSONS/SQ. MI.}$

## HYDROLOGY (cont.)

## 4. IMPERVIOUS Cover Index

$$I = 0.117 [D]^{0.792 - 0.039 \log_{10} D}$$

from Special Report 38 by U.S.G.S. with  
NJDEP 1974.

$$= 0.117 [430]^{0.792 - 0.039 \log_{10} D}$$

$$= 0.117 [430]^{0.792 - 0.10}$$

$$= 0.117 [430]^{0.688}$$

$$= 7.59 \%$$

## 5. Unit Hydrograph Parameters

$$TC + R = 21.0 (DA/S)^{0.22} (ST)^{0.33} (1.0 + 0.3 I)^{-0.28}$$

$$= 21.0 \left( \frac{132}{4.90} \right)^{0.22} (8.7)^{0.33} (1.0 + 0.3 \times 7.59)^{-0.28}$$

$$= 21.0 (26.9)^{0.22} (8.7)^{0.33} (3.277)^{-0.28}$$

$$TC + R = 63.5$$

$$TC = 6.82 (DA/S)^{0.17} (ST)^{0.41} (1.0 + 0.3 (I))^{-0.42}$$

$$= 6.82 \left( \frac{132}{4.90} \right)^{0.17} (8.7)^{0.41} (1.0 + 0.3 (7.59))^{-0.42}$$

$$= 6.82 (1.75) (2.43) (0.61)$$

$$= 12.69$$

## HYDROLOGY (cont.)

$$TC = 17.7$$

$$TC + R = 63.5$$

$$17.7 + R = 63.5$$

$$R = 45.8 \text{ Hrs.}$$

COMPUTER INPUT

FOR HEC-1-DAM INPUT USE

$$TC = 17.6 \text{ Hrs.}$$

$$R = 46.0 \text{ Hrs.}$$

PRECIPITATION (U.S.D.C. Rep. 40 pg 57)

Probable maximum precipitation = 27 inches for  
6 hours duration and 10 sq. mi. area.

Percentage of PMP for 132 sq. mi.

Duration (hr.)

% PMP

6

77

12

84

24

93

STORCH ENGINEERS

Sheet 5 of 9

Project

SMITHVILLE DAM

Made By JLP

Date 4-1-81

Chkd By JG

Date 4/10/81

LAKE STORAGE VOLUME

ELEVATION  
(ft.)

AREA  
(acres)

13.3

0

18.6

36.7

30

192.8

40

495.8

HEC-1-DAM COMPUTER PROGRAM WILL DEVELOP

STORAGE CAPACITY FROM WATER SURFACE AREA

AND ELEVATIONS. INFORMATION TAKEN FROM U.S.G.S.

QUADRANGLE MOUNT HOLLY, N.J.

## HYDRAULICS

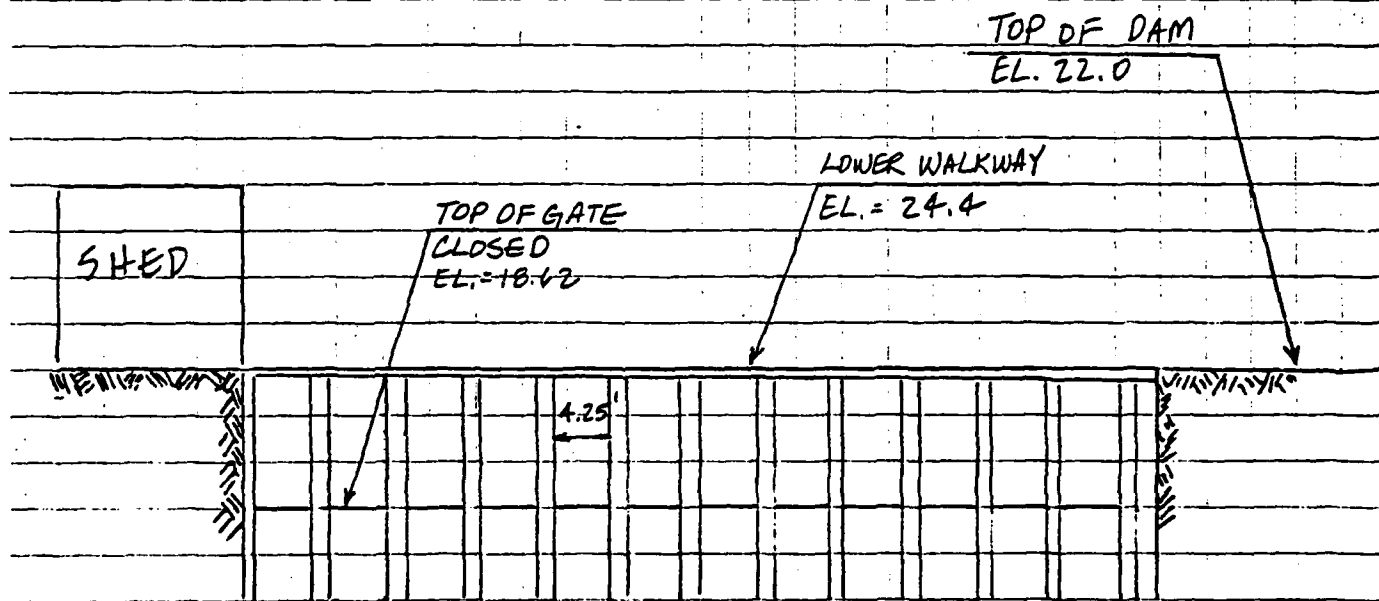
THE SPILLWAY AT SMITHVILLE LAKE DAM CONSISTS OF

12 SLIDE GATES FITTED IN A TIMBER FRAME CONSTRUCTED

ACROSS THE RIVER. DISCHARGE WILL BE COMPUTED AS

A SHARP CRESTED WEIR. DISCHARGE,  $Q$  CAN BE CALCULATED

$$AS \quad Q = CLH^{3/2}$$



where:

$C$  = discharge coefficient over spillway  
 $L$  = effective length of spillway (ft.)  
 $H$  = total head on spillway (ft.)  
 $Q$  = discharge over spillway (cfs)

STORCH ENGINEERS

Project

SMITHVILLE DAM

Sheet 7 of 9

Made By JLP Date 4-1-81

Chkd By JG Date 4/10/81

## SPILLWAY STAGE DISCHARGE TABULATION

| EL.<br>(ft.) | TAILWATER<br>EST (ft.) | C    | L<br>(ft.) | H<br>(ft.) | Q<br>(cfs) | x12 Q<br>(cfs) |
|--------------|------------------------|------|------------|------------|------------|----------------|
| 18.6         | —                      | 3.32 | 4.25       | 0.0        | 0          | 0              |
| 18.8         | —                      | 3.32 | 4.25       | 0.2        | 1.26       | 15             |
| 19.0         | —                      | 3.32 | 4.25       | 0.4        | 3.57       | 43             |
| 19.5         | 14                     | 3.32 | 4.25       | 0.9        | 12.05      | 145            |
| 20.0         | 15                     | 3.32 | 4.25       | 1.4        | 23.37      | 280            |
| 21.0         | 17                     | 3.32 | 4.25       | 2.4        | 52.46      | 630            |
| 22.0         | 18                     | 3.32 | 4.25       | 3.4        | 88.45      | 1062           |
| 24.0         | 21*                    | 2.89 | 4.25       | 5.4        | 154.1      | 1850           |
| 26.0         | 24*                    | 2.29 | 4.25       | 7.4        | 195.9      | 2351           |
| 30.0         | 28*                    | 1.93 | 4.25       | 11.4       | 315.7      | 3789           |
| 34.0         | 32*                    | 1.73 | 4.25       | 15.4       | 444.3      | 5332           |

\* Submerged Weir

STORCH ENGINEERS

Project

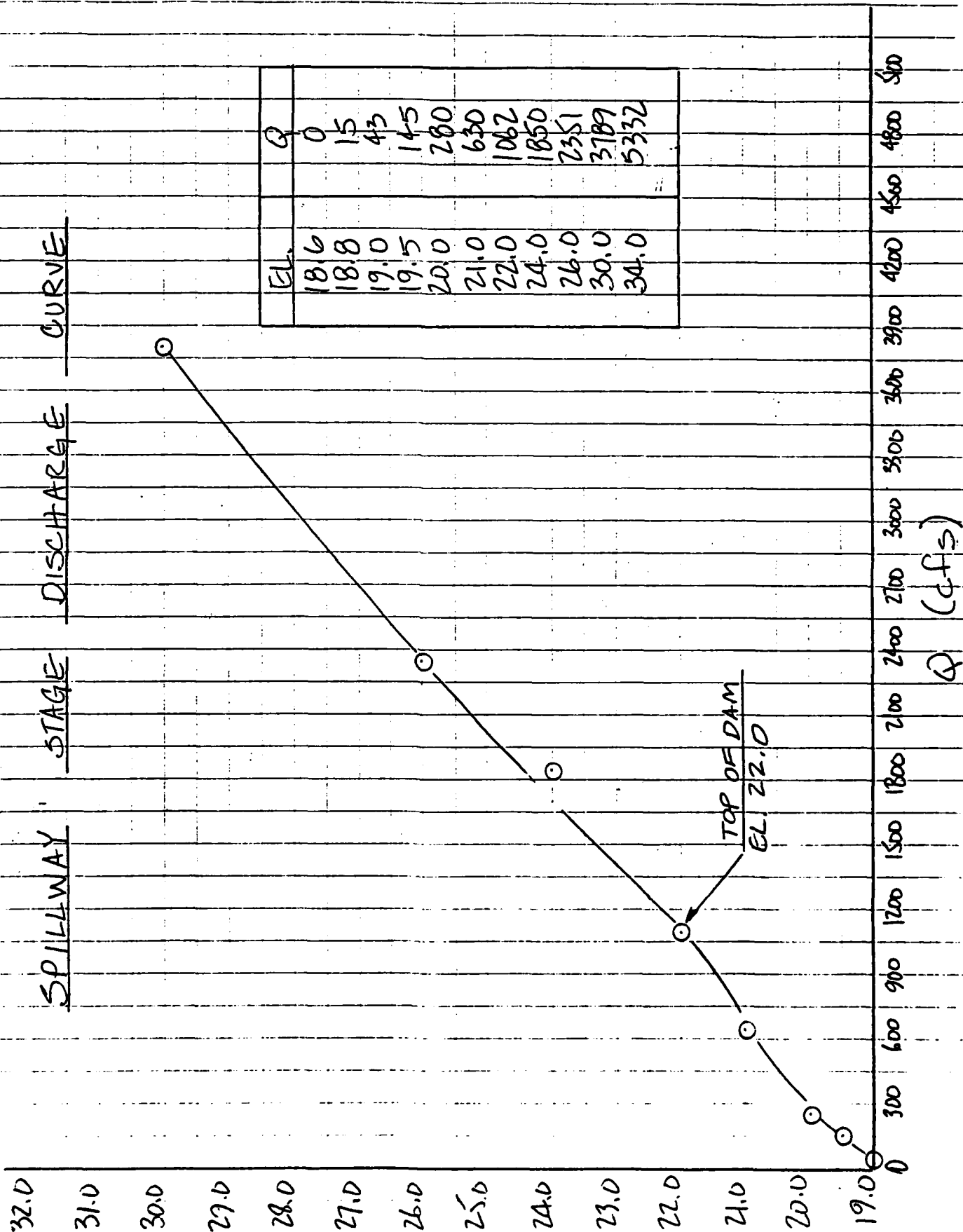
SMITHVILLE DAM

Sheet 8 of 9

Made By JLP Date 4-6-81

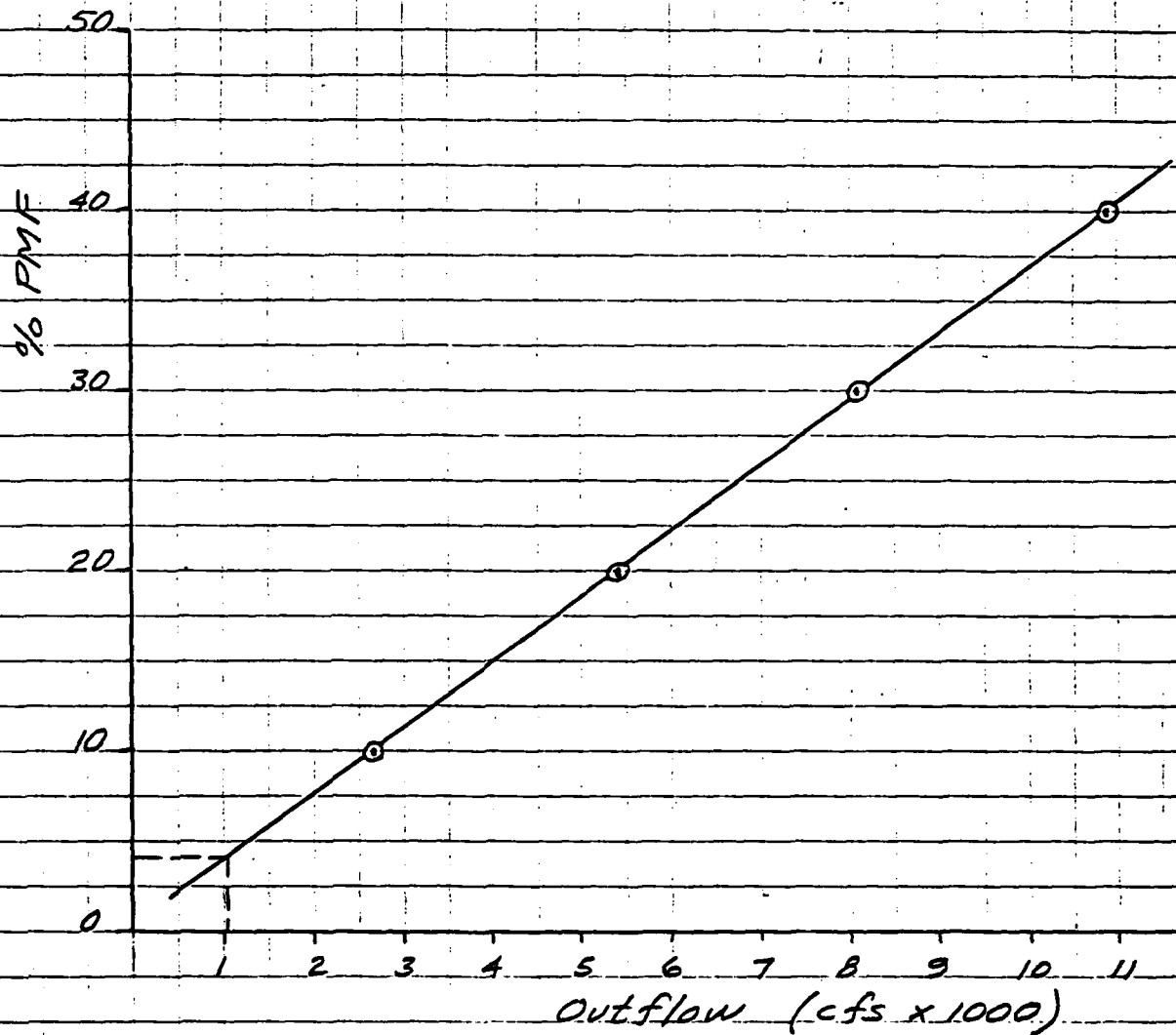
Chkd By JG Date 4/10/81

SCALE 4 X 4 TO THE INCH



OVERTOPPING POTENTIAL

SQUARE 4 X 4 10 THE INCH



Overtopping of dam occurs at elev. 22.0  
with discharge  $Q = 1062$  cfs.

Dam can pass approx. 4% PMF

HEC - 1 - DAM PRINTOUT

Overtopping Analysis

|     |                                          |       |       |       |      |      |       |      |      |      |
|-----|------------------------------------------|-------|-------|-------|------|------|-------|------|------|------|
| 1A1 | NATIONAL DAM SAFETY PROGRAM              |       |       |       |      |      |       |      |      |      |
| A2  | SMITHVILLE DAM, NEW JERSEY               |       |       |       |      |      |       |      |      |      |
| A3  | MULTI RATIO ROUTING                      |       |       |       |      |      |       |      |      |      |
| B   | 300                                      | 1     | 0     |       |      |      | 0     | 0    | 4    |      |
| B1  | 5                                        |       |       |       |      |      |       |      |      |      |
| J   | 1                                        | 5     | 1     |       |      |      |       |      |      |      |
| J1  | 0.5                                      | 0.4   | 0.3   | 0.2   | 0.1  |      |       |      |      |      |
| K   | 0                                        | LAKE  |       |       | 0    | 0    | 1     |      |      |      |
| K1  | INFLOW HYDROGRAPH TO SMITHVILLE LAKE DAM |       |       |       |      |      |       |      |      |      |
| M   | 1                                        | 0     | 132   |       | 132  | 0    |       |      | 1    |      |
| P   | 0                                        | 27    | 77    | 84    | 93   |      |       |      |      |      |
| T   |                                          |       |       |       |      |      | 1.5   | 0.15 |      |      |
| V   | 17.7                                     | 45.8  | 0     |       |      |      |       |      |      |      |
| X   | -1.0                                     | -0.05 | 2.0   |       |      |      |       |      |      |      |
| K   | 1                                        | DAM   |       |       | 0    | 0    | 1     |      |      |      |
| K1  | ROUTE DISCHARGE THRU DAM                 |       |       |       |      |      |       |      |      |      |
| Y   |                                          |       | 1     | 1     |      |      |       |      |      |      |
| Y1  | 1                                        |       |       |       |      |      | -18.6 | -1   |      |      |
| Y4  | 18.6                                     | 18.8  | 19.0  | 19.5  | 20.0 | 21.0 | 22.0  | 24.0 | 26.0 | 30.0 |
| Y5  | 0                                        | 15    | 43    | 145   | 280  | 630  | 1062  | 1850 | 2351 | 3789 |
| 9A  | 0                                        | 36.7  | 192.8 | 495.8 |      |      |       |      |      |      |
| 9E  | 13.3                                     | 18.6  | 30.0  | 40.0  |      |      |       |      |      |      |
| 99  | 18.6                                     |       |       |       |      |      |       |      |      |      |
| 9D  | 22.0                                     | 2.63  | 1.5   | 500   |      |      |       |      |      |      |

NATIONAL DAM SAFETY PROGRAM  
SMITHVILLE DAM, NEW JERSEY  
MULTI RATIO ROUTING

NO MHR ' NHIN IDAY IHR ININ METRC IFLT IPRT NSTAN  
300 1 0 0 0 0 0 0 0 0 0 0 0  
JOFR 5 0 0 0 0 0 0 0 0 0 0 0

MULTI-PLAN ANALYSES TO BE PERFORMED

RTIOS .50 .40 .30 .20 .10  
NELAN=1 NRLO=5 LRLO=1

\*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\*

SUB-AREA RUNOFF COMPUTATION

INELON HYDROGRAPH TO SMITHVILLE LAKE DAM

ISTAG ICOMP IECON ITAPE JFLT JFRT INAME ISTAGE IAUTO  
LAKE 0 0 0 0 0 0 1 0 0

HYDROGRAPH DATA  
INHYD0 IUNG TAREA SNAF TRSDA TRSPC RATIO ISHOW ISASE LOCAL  
1 0 132.00 0.00 132.00 0.00 0.000 0.000 0 1 0

PRECIP DATA

SPFE PMS R6 R12 R24 R48 R72 R96  
0.00 27.00 77.00 84.00 93.00 0.00 0.00 0.00

LOSS DATA

LRQPI SIKR OLKR RJDL ERAN SIKS RILOK SIRTJ CHSTL ALSHX RTIMP  
0 0.00 0.00 1.00 0.00 0.00 1.00 1.50 .15 0.00 0.00

UNIJ HYDROGRAPH DATA

TC= 17.70 R= 45.80 NTA= 0

RECESSION DATA

STRIO= -1.00 GRCSN= -.05 RTIOR= 2.00

| UNIJ HYDROGRAPH 100 END-OF-PERIOD ORIGINATES, LOG= 17.68 HOURS, CF= .31 VOL= .86 |       |       |       |       |       |       |       |       |       |
|----------------------------------------------------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 17.                                                                              | 66.   | 138.  | 226.  | 325.  | 435.  | 554.  | 680.  | 814.  | 947.  |
| 1072.                                                                            | 1184. | 1284. | 1369. | 1440. | 1495. | 1530. | 1535. | 1512. | 1480. |
| 1498.                                                                            | 1417. | 1386. | 1356. | 1327. | 1298. | 1270. | 1243. | 1216. | 1190. |
| 1164.                                                                            | 1139. | 1114. | 1090. | 1066. | 1043. | 1021. | 999.  | 977.  | 956.  |
| 936.                                                                             | 915.  | 896.  | 876.  | 857.  | 839.  | 821.  | 803.  | 786.  | 769.  |
| 752.                                                                             | 736.  | 720.  | 704.  | 689.  | 674.  | 660.  | 645.  | 631.  | 618.  |
| 605.                                                                             | 591.  | 579.  | 566.  | 554.  | 542.  | 530.  | 519.  | 508.  | 497.  |
| 486.                                                                             | 475.  | 465.  | 455.  | 445.  | 436.  | 426.  | 417.  | 408.  | 399.  |
| 391.                                                                             | 382.  | 374.  | 366.  | 358.  | 350.  | 343.  | 335.  | 328.  | 321.  |
| 314.                                                                             | 307.  | 301.  | 294.  | 288.  | 282.  | 275.  | 269.  | 264.  | 258.  |

NO.DA HR.MN PERIOD RAIN EXCS LOSS END-OF-PERIOD FLOW NO.DA HR.MN PERIOD RAIN EXCS LOSS CONF 0

SUM 21.93 18.09 3.85 1348301.  
( 867.1 ) ( 409.1 ) ( 98.1 ) ( 38179.63 )

# HYDROGRAPH ROUTING

## ROUTE DISCHARGE THRU DAM

|               |       |       |        |        |        |        |         |         |
|---------------|-------|-------|--------|--------|--------|--------|---------|---------|
| ISTAD         | ICOMP | IFCON | ITDPE  | JELT   | JERT   | INOME  | ISTAGE  | IAUTO   |
| DAM           | 1     | 0     | 0      | 0      | 0      | 1      | 0       | 0       |
| ROUTING DATA  |       |       |        |        |        |        |         |         |
| GLLOSS        | CLOSS | AVG   | IRCS   | ISOME  | IOFT   | IPMF   | LSTR    |         |
| 0.0           | 0.000 | 0.00  | 1      | 1      | 0      | 0      | 0       |         |
| NSIPS         |       |       |        |        |        |        |         |         |
| NSIPS         | NSIDL | LAG   | ANSKK  | X      | ISK    | SIORA  | ISPRAT  |         |
| 1             | 0     | 0     | 0.000  | 0.000  | 0.000  | -19.   | -1      |         |
| STAGE         | 18.60 | 18.80 | 19.00  | 19.50  | 20.00  | 21.00  | 22.00   | 24.00   |
|               |       |       |        |        |        |        |         | 26.00   |
|               |       |       |        |        |        |        |         | 30.00   |
| FLOW          | 0.00  | 15.00 | 43.00  | 145.00 | 280.00 | 630.00 | 1062.00 | 1850.00 |
|               |       |       |        |        |        |        |         | 2351.00 |
|               |       |       |        |        |        |        |         | 3789.00 |
| SURFACE AREA= |       |       |        |        |        |        |         |         |
|               | 0.    | 37.   | 193.   | 496.   |        |        |         |         |
| CAPACITY=     |       |       |        |        |        |        |         |         |
|               | 0.    | 65.   | 1257.  | 4583.  |        |        |         |         |
| ELEVATION=    |       |       |        |        |        |        |         |         |
|               | 13.   | 19.   | 30.    | 40.    |        |        |         |         |
| CREL          |       |       |        |        |        |        |         |         |
| 18.6          | 0.0   | 0.0   | 0.0    | 0.0    | 0.0    | 0.0    | 0.0     | 0.0     |
| EXPW          |       |       |        |        |        |        |         |         |
|               | 0.0   | 0.0   | 0.0    | 0.0    | 0.0    | 0.0    | 0.0     | 0.0     |
| ELEV          |       |       |        |        |        |        |         |         |
|               | 0.0   | 0.0   | 0.0    | 0.0    | 0.0    | 0.0    | 0.0     | 0.0     |
| COOL          |       |       |        |        |        |        |         |         |
|               | 0.0   | 0.0   | 0.0    | 0.0    | 0.0    | 0.0    | 0.0     | 0.0     |
| CAREA         |       |       |        |        |        |        |         |         |
|               | 0.0   | 0.0   | 0.0    | 0.0    | 0.0    | 0.0    | 0.0     | 0.0     |
| EXPL          |       |       |        |        |        |        |         |         |
|               | 0.0   | 0.0   | 0.0    | 0.0    | 0.0    | 0.0    | 0.0     | 0.0     |
| DAM DATA      |       |       |        |        |        |        |         |         |
| TOPEL         | COOD  | EXPD  | DAMWID |        |        |        |         |         |
| 22.0          | 2.6   | 1.5   | 500.   |        |        |        |         |         |

PEAK OUTFLOW IS 13589. AT TIME 33.00 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS  
 FLOWS IN CURIC FEET PER SECOND (CURIC METERS PER SECOND)  
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

| OPERATION     | STATION | AREA      | PLAN | RATIOS APPLIED TO FLOWS |           |           |           |          |
|---------------|---------|-----------|------|-------------------------|-----------|-----------|-----------|----------|
|               |         |           |      | RATIO 1                 | RATIO 2   | RATIO 3   | RATIO 4   | RATIO 5  |
|               |         |           |      | .50                     | .40       | .30       | .20       | .10      |
| HYDROGRAPH AT | LAKE    | 132.00    | 1    | 13592.                  | 10873.    | 8155.     | 5437.     | 2718.    |
|               |         | ( 341.88) | (    | 384.87)                 | ( 307.90) | ( 230.92) | ( 153.95) | ( 76.97) |
| ROUTED TO     | DAM     | 132.00    | 1    | 13589.                  | 10871.    | 8153.     | 5435.     | 2716.    |
|               |         | ( 341.88) | (    | 384.81)                 | ( 307.83) | ( 230.86) | ( 153.91) | ( 76.92) |
| ROUTED TO     | 1       | 132.00    | 1    | 13581.                  | 10863.    | 8146.     | 5428.     | 2712.    |
|               |         | ( 341.88) | (    | 384.58)                 | ( 307.61) | ( 230.68) | ( 153.72) | ( 76.79) |

SUMMARY OF DAM SAFETY ANALYSIS

| PLAN | RATIO OF PMF | MAXIMUM RESERVOIR W.S. ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|------|--------------|-----------------------------|------------------------|-----------------------|---------------------|-------------------------|---------------------------|-----------------------|
|      |              |                             |                        |                       |                     |                         |                           |                       |
| 1    |              | ELEVATION                   | INITIAL VALUE          | SPILLWAY CREST        | TOP OF DAM          |                         |                           |                       |
|      |              | STORAGE                     | 18.60                  | 18.60                 | 22.00               |                         |                           |                       |
|      |              | OUTFLOW                     | 65.                    | 65.                   | 244.                |                         |                           |                       |
|      |              |                             | 0.                     | 0.                    | 0.                  |                         |                           |                       |
|      | .50          | 26.17                       | 4.17                   | 649.                  | 13589.              | 98.00                   | 33.00                     | 0.00                  |
|      | .40          | 25.51                       | 3.51                   | 569.                  | 10871.              | 97.00                   | 33.00                     | 0.00                  |
|      | .30          | 24.78                       | 2.78                   | 488.                  | 8153.               | 96.00                   | 33.00                     | 0.00                  |
|      | .20          | 23.96                       | 1.96                   | 405.                  | 5435.               | 89.00                   | 33.00                     | 0.00                  |
|      | .10          | 22.98                       | .98                    | 318.                  | 2716.               | 55.00                   | 33.00                     | 0.00                  |

APPENDIX 5

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