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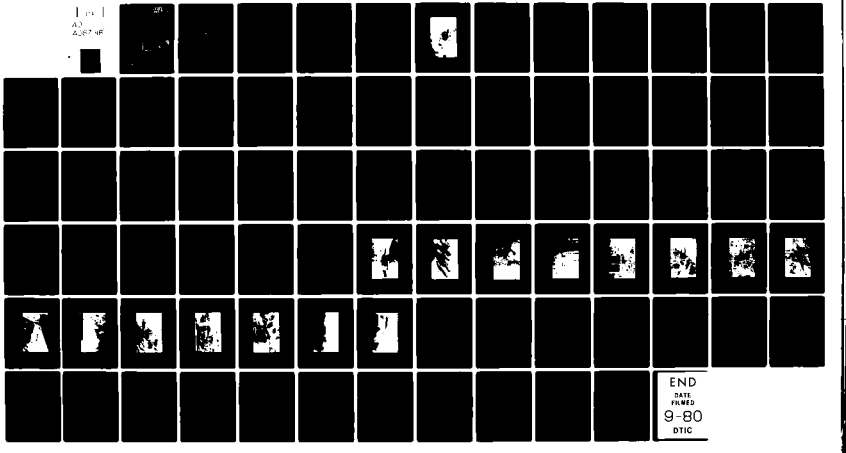

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DELAWARE RIVER BASIN
PINE CREEK, SCHUYLKILL COUNTY

PENNSYLVANIA
NDS ID PA. 00669
DER ID 54-67

KUNKLES DAM

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

WOODWARD-CLYDE CONSULTANTS
DACW31-80-C-0018

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

JUNE 1980

(6) National Dam Insp Prog Program.
Kunkles Dam

DELAWARE RIVER BASIN,
Pine Creek,
KUNKLES DAM, SCHUYLKILL COUNTY,
PENNSYLVANIA.

Number

(NDS I.D. PA 00669,
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NATIONAL DAM INSPECTION PROGRAM

(11) June 80

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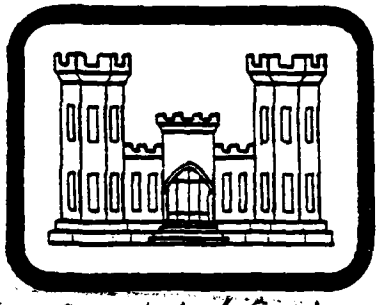

(15) DACW31-80-C-0018

Prepared by:

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5120 Butler Pike
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Submitted to:

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

JUNE 1980

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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 the Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to expeditiously identify those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for more detailed studies.

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

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected, and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam:	Kunkles Dam
County Located:	Schuylkill County
State Located:	Pennsylvania
Stream:	Pine Creek
Coordinates:	Latitude 40° 40.7'
	Longitude 76° 3.0'
Date of Inspection:	May 1, 1980

Kunkles Dam is a privately owned dam used for recreational purposes. The dam and spillway structures of Kunkles Dam are currently in poor condition.

In accordance with criteria established by Federal (OCE) Guidelines, the recommended spillway design flood for this "Small" size dam and "Significant" hazard potential classification is the 100 Year Flood to one-half the Probable Maximum Flood (PMF). Based on the small capacity of the reservoir and the fact that no loss of life is likely during failure of the structure, the 100 Year Event has been selected as the spillway design flood.

Hydrologic and hydraulic computations presented in Appendix D indicate that the spillway structure is not capable of discharging the 100 Year Event without overtopping the embankment by about 0.8 foot for about 3.5 hours. The structure is considered to have an "Inadequate" spillway as it will not pass the spillway design flood without overtopping the embankment.

It is recommended that the following measures be undertaken immediately. Items (1) through (4) should be performed under the supervision of a registered professional engineer experienced in the design and construction of dams.

(1) A detailed hydrologic/hydraulic study should be made and the spillway upgraded to meet current hydrologic/hydraulic criteria.

(2) A study should be made to determine the best method of removing trees without increasing potential hazard of dam failure by piping through root channels.

(3) Seepage through the dam should be monitored for the development of turbidity and an increase in quantity.

(4) Damage to the upstream edge of the crest and the upstream embankment at the waterline should be repaired.

(5) The blowoff pipe through the spillway, the outlet pipe to the downstream sawmill and the chilled water line should be fitted at the upstream end with operational control devices.

(6) All joints of the spillway walls should be sealed to prevent further deterioration. Dislodged stones of the spillway wall should be replaced.

Because of the potential for property damage in the event of failure, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented for this facility. This procedure could be coordinated with local authorities and should include a method of warning downstream residents that high flows are expected. In addition, an operation and maintenance procedure should also be developed to insure that all pertinent items are carefully inspected on a regular basis and maintained in the best possible condition.

Mary F. Beck — 6/30/80

Mary F. Beck, P.E.
Pennsylvania Registration 27447E
Woodward-Clyde Consultants

Date

Frank S. Waller — 6/30/80

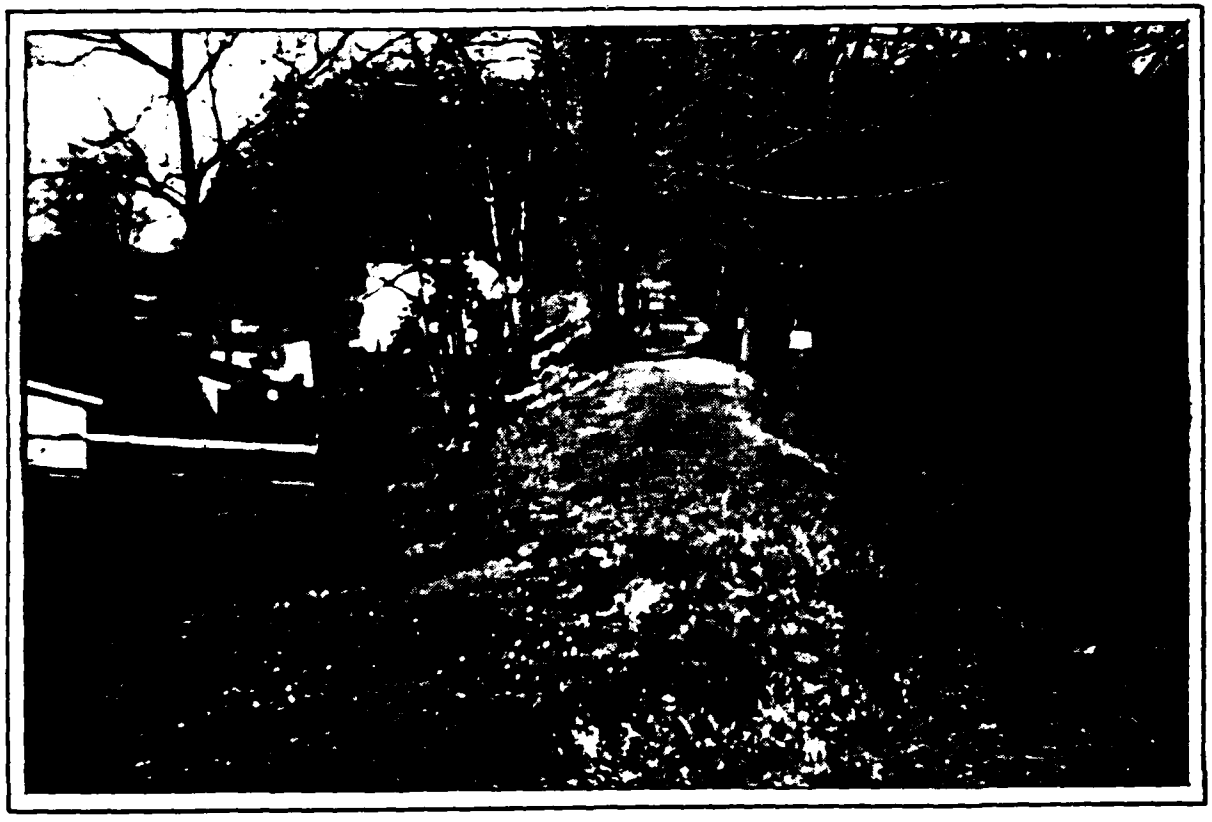
for John H. Frederick, Jr., P.E.
Maryland Registration 7301
Woodward-Clyde Consultants

Date

APPROVED BY:

[signature] — 31 July 1980

Date



OVERVIEW
KUNKLES DAM, SCHUYLKILL COUNTY, PENNSYLVANIA

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
KUNKLES DAM
NATIONAL ID NO. PA 00669
DER NO. 54-67

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Kunkles Dam is a 110 year old earth/rock fill dam about 21.4 feet high and 434 feet long. No drawings or reliable information concerning the interior of this dam exist. Therefore, the physical description is drawn from visual observation and from information obtained by the state from Mr. Jonas Kunkle, the owner in 1915, and from observations of Mr. Harry Kunkle, the present owner.

The upstream slope above the waterline ranges from nearly vertical to 2.5H:1V, and is generally covered with trees, brush and grass with some bare earth exposed by foot traffic. Below the waterline, the embankment appears to be earth with shale fragments. The crest of the dam ranges from 8 to 12 feet wide and is uneven. Part of the crest is covered with grass and part with shale. The 1915 report indicates that the inspecting engineer believed that the "upper" (upstream?) portion of the dam was composed of select material, and the downstream portion was rock fill. The downstream embankment between the spillway and the right abutment appears to be rock fill. To the left of the spillway, for a distance of about 90 feet, the downstream embankment is a vertical masonry wall extending nearly the full height of the dam. Either the height of this masonry wall decreases toward its left end or loose rock fill obscures

the base of the wall. Between the end of the masonry wall and the left abutment, the downstream embankment appears composed of earth and rock. About 100 feet from the left abutment, a set of stone steps provides access to the crest of the dam.

As shown in Photographs 1, 2 and 3, the spillway is constructed of rock. The upstream side of the spillway crest is apparently constructed of select materials and has a flatter slope than the embankment upstream slope. Apparently, the entire downstream portion is constructed of rock. Originally, the rock was grouted and, about 10 to 12 years ago, the Owner placed concrete over the rock near the crest of the spillway. Prior to that, water flowed over the crest and into the rock. The water now flows most of the way down the spillway before entering into the rock. The spillway crest width is 45 feet, and the height of the spillway walls above the crest is about three feet. The spillway walls are about nine feet thick at the crest, narrowing to 3.5 feet wide down the slope, and are constructed of mortared stone. Remnants of an old wooden weir can be seen at the crest.

A 24 inch cast iron blowoff pipe was laid through the spillway. The upstream end of this pipe was reported sealed with a wooden cover, packed with straw and covered with about three feet of earth. As shown in Photograph 3, the closure was no longer complete and water was flowing through the conduit at the time of the visual inspection.

The original purpose of this dam was to power a sawmill located immediately downstream, shown on Plate 2, Appendix E. The 18 inch conduit to the sawmill, reportedly laid through the dam just above original ground, has an inoperable sluice gate at the upstream end. Water through the conduit powered a turbine and discharged into a millrace at the downstream toe of the dam. The race approximately parallels the toe of the dam and joins the spillway discharge shortly below the downstream end of the spillway. The sawmill is presently in ruins, but the foundation appears to be intact.

A four inch chilled water line passes through the embankment near the right abutment. The screened intake is underwater. The line supplies chilled water to a compressor located in a cold storage building immediately downstream of the dam.

There are no reports concerning the interior of the dam. Therefore, it is unknown whether there are any interior cutoff walls or trenches, or anti-seep collars around the conduits through the dam.

b. Location. The dam is located on Pine Creek in East Brunswick Township, Schuylkill County, Pennsylvania. The dam site is about 1.4 miles west of McKeansburg on Pennsylvania Route 443. The site is shown on the USGS Quadrangle entitled "Orwigsburg, Pennsylvania" at coordinates N 40° 40.7' W 76° 3.0'. A regional location plan of Kunkles Dam is enclosed as Plate 1, Appendix E.

c. Size Classification. The dam is classified as a "Small" size structure by virtue of its estimated 67 acre-foot total storage capacity and less than 40 foot height.

d. Hazard Classification. A "Significant" hazard classification is assigned consistent with the potential for appreciable economic damage, but with few or no lives lost.

e. Ownership. The dam is owned by Mr. Harry N. Kunkle. All correspondence should be sent to Mr. Kunkle at Kunkle Farms, RD #1, Orwigsburg, Pennsylvania 17961.

f. Purpose of Dam. Presently, this dam is leased to a fishing club and the reservoir is primarily used for recreational purposes.

g. Design and Construction History. Kunkles Dam was reportedly built in 1870 by members of the Kunkle family without the aid of drawings, specifications or engineering advice. In 1895, the dam suffered a partial failure, resulting from inadequate spillway capacity. When repairs were made to the dam, an engineer was reportedly consulted, but his identification is unknown. No plans or specifications exist for the present spillway, which was constructed at that time. The downstream masonry wall was constructed after the dam was completed, but prior to 1915, to afford a passageway between the mill and the dam. Records located in Department of Environmental Resources (DER) files indicate that a drawdown permit was received in 1935 to repair gates, and again in 1940 to repair a hole in the breast and a gate.

Other records in DER files are primarily limited to periodic inspection reports. These reports indicate that trees have been growing on the upstream and downstream slopes of the dam since 1919, and that seepage at the downstream toe has been noted since 1924.

In 1972, during Tropical Storm Agnes, the lake level reportedly increased to nearly the height of the spillway walls, three feet over the spillway crest, causing the Owner some concern that the dam might be overtopped. During the storm, the Owner directed that the embankment at its junction with the left abutment be lowered, where the height of the

embankment was fairly low. The Owner reasoned that it would be better for the embankment to be overtopped at this point rather than at the maximum section. Before the embankment could be lowered, the rains stopped and the reservoir level crested without overflowing the embankment at any point.

h. Normal Operating Procedures. Under normal conditions, all flow is discharged over the stone spillway. There are no minimum flow requirements downstream of this dam.

1.3 Pertinent Data.

A summary of pertinent data for Kunkles Dam is presented as follows.

a.	Drainage Area (square miles)	2.4
b.	Discharge at Dam Site (cfs)	
	Maximum Known Flood	Unknown
	At Minimum Embankment Crest	830
c.	Elevation (feet above MSL)(1)	
	Top of Dam	692.7
	Spillway Crest	689.8
	Tailwater (5/1/80)	672.2
	Stream Bed At Spillway	671.3
d.	Reservoir (feet)	
	Length at Normal Pool	1,100
	Length at Maximum Pool (est)	1,400
e.	Storage (acre-feet)	
	Normal Pool (est)	44
	Top of Dam (est)	67
f.	Reservoir Surface (acres)	
	Normal Pool	7.4
g.	Dam Data	
	Type	Earth/rock fill
	Length	434 feet
	Slopes	
	Upstream (above water line)	Vertical to 2.5H:1V
	Downstream	Vertical to 1.8H:1V to 2.0H:1V
	Volume	9,700 cubic yards

(1) All elevations are relative to reservoir level, assumed to be elevation 690.0 at time of inspection.

	Height (above stream bed)	21.4 feet
	Crest Width	8 to 12 feet
	Cutoff	Unknown
	Grout Curtain	Unknown
h.	Spillway	
	Type	Masonry weir, grouted near crest
	Elevation At Crest	689.8 feet
	Length	45 feet
i.	Outlet Works	
	Type	18 inch steel conduit with inoperable upstream sluice gate
	Length	Unknown
	Inlet Invert Elevation	Unknown
	Outlet Invert Elevation	678.8 feet
j.	Pond Drain	
	Type	24" cast iron conduit partially closed at upstream end
	Length	Unknown
	Inlet Invert Elevation	Unknown
	Outlet Invert Elevation	671.5

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Data Available. There are no original engineering data for Kunkles Dam. Subsequent evaluation data are limited to an estimate of the spillway capacity made by the state in 1915.

b. Design Features. A plan view of the dam and a section through the spillway are presented in Appendix E and were obtained from the visual inspection. A summary of the features of the dam is included in Section 1.3.

2.2 Construction.

Nothing is known concerning the construction history beyond the information given in Section 1.2, paragraph g.

2.3 Operational Data.

There are no operational records maintained for this dam.

2.4 Evaluation.

a. Availability. All information presented herein was obtained from reports and correspondence from Pennsylvania Department of Environmental Resources files and supplemented by conversations with the Owner.

b. Adequacy. The available data are not adequate to evaluate the engineering aspects of this dam.

c. Validity. There is no reason to question the validity of the limited available data.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. Observations and comments of the field inspection team are contained in the checklist enclosed herein as Appendix A, and are summarized and evaluated in the following subsections. In general, the appearance of the facilities indicates that the dam is currently in poor condition and is not well maintained.

b. Dam. The vertical alignment of the dam crest was checked, and the profile is shown on sheet 5B, Appendix A. Although the vertical profile is uneven, there are no distortions in alignment that would be indicative of deep-seated movement of the embankment or foundation. The minimum crest elevation is about 0.6 feet below the right spillway wall. The upstream slope below the waterline appears to be earth with shale fragments. It is possible that this overlies paving, according to the 1915 report in Department of Environmental Resources files. Above the waterline, the embankment ranges from nearly vertical to about 2.5H:1V. Brush and trees are growing at the waterline in many places, as shown in Photographs 5 and 6. Waves have benched the upstream slope and have undercut the slope under a tree at the upstream side to the right of the spillway. The crest of the dam ranges from 8 to 12 feet in width and is protected with grass and shale fragments. Swales have been worn by foot traffic and/or erosion over the upstream edge of the crest. The downstream slope consists of a dry masonry wall, shown in Photograph 7, which was constructed after the dam was built, from the spillway to a point about 90 feet left of the spillway. Either the height of this wall decreases towards the left or rock fill has been placed at the base of the wall. Elsewhere, the downstream slope ranges from vertical to about 1.8H:1V to 2.0H:1V. The downstream slope is generally covered with rock fill which is loose and slides underfoot. However, between the end of the downstream masonry wall and the left abutment, shown in Photograph 8, the surficial embankment materials contain more soil, permitting grass to grow on the embankment. About halfway between the end of the vertical wall and the left abutment, stone steps were constructed up the face of the dam, but foot traffic has worn paths over the downstream face of the dam. Several large trees, ranging between one and two feet in diameter, are also growing on the downstream slope of the embankment. In the vicinity of the left abutment, the downstream slope is uneven as a result of the attempt to lower the embankment crest during Tropical Storm Agnes, June 1972.

There is a considerable amount of seepage at the downstream toe of this dam. As shown on Photograph 2, discharge over the spillway enters the spillway rock and exits in the downstream channel. Photographs 9 and 10 show the seepage through the dam between the spillway and the right abutment. Photograph 9 shows a barrel embedded at the downstream toe where seepage exits the dam. The Owner reported that there is almost always a constant amount of seepage from this point. Photograph 10 shows the amount of seepage that is entering the channel between the end of the spillway wall and the adjacent cold storage building. The amount of seepage here is in direct correlation with the reservoir level, according to the Owner. At the time of the inspection, the reservoir was relatively high due to four days of rainfall prior to the inspection. Photograph 11 shows an old tree stump about 1.5 feet in diameter adjacent to the left spillway wall. The center of the stump and the tap root have rotted and, by looking into the stump, a large amount of seepage can be seen flowing through the dam about 40 inches below the ground surface, which is approximately the same elevation as the water level in the spillway channel. A considerable amount of seepage is also entering the spillway channel from behind the downstream left spillway wall. Seepage can also be seen exiting the dam below the level of the outlet pipe to the sawmill turbine, shown in Photograph 4. This seepage is collected in the millrace at the downstream toe of the dam and is conveyed to the spillway discharge channel below the dam. All seepage was observed to be clear, and no evidence of migration of fines through the dam was noted.

At the toe of the dam near the left abutment, effluent from an on-site sewage disposal system of a nearby residence is discharged on the ground. The effluent runs along the toe of the slope until it disappears by seeping into the ground.

c. Appurtenant Structures. The masonry spillway walls were observed to be in poor condition with severe deterioration of the mortar joints and dislocation of some of the stones, as shown in Photographs 12 and 13. Photograph 12 shows the dislocation of a large stone at the upstream end of the spillway, and Photograph 13 shows the general deterioration of the concrete joints at a point where the walls join the floor. The last known maintenance of the spillway was about 10 to 12 years ago, when the Owner placed new concrete over the stones near the crest of the spillway. Water flowing over the spillway crest enters the rock and flows through the rock to the downstream channel. As can be seen in Photograph 3, rock at the downstream end of the spillway channel is dry.

A 24 inch blowoff pipe passes through the stone spillway, as shown in Photograh 3. Originally, this pipe was controlled by a sluice gate at its upstream end. The Owner reported that the gate was inoperable and that a few years ago the end was sealed with wood, packed with straw and covered with three feet of earth. The Owner reported that the conduit was sealed but, at the time of the inspection, water was flowing through the conduit. This flow has eroded a channel downstream of the dam, indicating that the conduit has been flowing for some time. No remnants of the sluice gate can be seen in the reservoir. Flow through the outlet pipe to the sawmill was also controlled by a sluice gate at the upstream end. The gate is inoperable, and the Owner has plans to repair the gate this spring or summer. At the time of the inspection, a small amount of flow could be heard passing through the outlet conduit. Wooden support posts for the sluice gate can be seen in the reservoir.

d. Reservoir. The reservoir side slopes are generally steep and well vegetated to the water's edge with grass and trees. A considerable amount of sediment is accumulating at the upper end of the reservoir, with about 0.5 acre of surface sediment about one foot above the spillway level. The rest of the sediment is being deposited below the normal pool elevation. About two years ago, the deepest portion of the lake was measured to be about 20 feet deep upstream of the spillway. This indicates that the sediment may be confined to the upper end of the reservoir.

e. Downstream Channel. At the downstream toe, between the spillway and the right abutment, is a building used for apple cold storage as well as farm equipment storage. This building is also owned by Mr. Kunkle. At the downstream toe near the left end of the dam is a garage and workshop that is not owned by Mr. Kunkle. About 250 feet downstream of the spillway, the channel passes under Pennsylvania Route 443. The bridge opening is about 15 feet wide and 7.5 feet high. The highway grade decreases toward the west, the area shown in Photograph 14. During high flows, water flows over the highway and downstream, rather than just through the highway bridge. About 900 feet below the dam, the channel flows alongside a farmstead consisting of a house and several buildings, also shown in Photograph 14. The structure located closest to the creek is a garage. The Owner has reported that the maximum water level at a time when the water was flowing over the highway was no closer than 20 feet to the garage. Reports indicate that when the dam partially failed in 1895, water did not reach the farmhouse. About 1,500 feet farther downstream is another house, which is shown in Photograph 15. The rear door of the house is approximately 2.5 feet above the elevation of the stream bank. About 1,300 feet farther

downstream, Pine Creek supplies water to several commercial fishing ponds, shown on Plate 1. No other homes were noted to be within six feet above the channel bank. Therefore, a "Significant" hazard classification for this structure is warranted.

3.2 Evaluation.

Inspection of the dam and appurtenant facilities indicates that little or no routine maintenance has been provided to the structure, and the spillway and embankment are in poor condition. Items of a routine nature include sealing all open joints on the spillway walls to prevent further deterioration. Also, the sluice gate to the sawmill conduit should be made operational and the blowoff conduit through the spillway be fitted with an upstream control device.

Photographs taken by the state in 1915 indicate that trees were growing on both the upstream and downstream embankments at that time. Therefore, it is probable that the root systems are extensive and extend completely through the dam. As evidenced by the decayed taproot of the stump near the spillway, large roots create voids in the embankments. Therefore, the trees cannot be removed without considering the long-term effects on the stability of the embankment. Damage to the upstream edge of the crest and upstream embankment at the waterline should be repaired.

Seepage through the dam is assessed to represent a long-term condition, which requires monitoring for development of turbidity or an increase in volume not associated with an increase in reservoir level. In summary, the dam and its appurtenant facilities are considered to be in poor condition.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures.

Operation of the dam does not require a dam tender. All flow discharges directly over the spillway crest and downstream into Pine Creek.

4.2 Maintenance of the Dam.

Maintenance of the dam is limited to removal of debris and generally is performed by members of the fishing club who rent the dam from the Owner.

4.3 Maintenance of Operating Facilities.

Maintenance of the operating facilities is provided by the Owner. The Owner currently plans to make the sluice gate to the sawmill conduit operational sometime this spring or summer.

4.4 Warning Systems In Effect.

There are no formal warning systems or procedures to be established during periods of exceedingly heavy rainfalls.

4.5 Evaluation.

There are no written operational procedures, maintenance procedures or any type of warning system. Maintenance and operating procedures should be developed including a checklist of items to be observed, operated and inspected on a regular basis.

Since a formal warning procedure does not exist, one should be developed and implemented during periods of extreme rainfall. This procedure should consist of a method of notifying residents downstream that potentially high flows are imminent or dangerous conditions are developing.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features.

a. Design/Evaluation Data. There are no original design data for this structure, and subsequent evaluation data are limited to an evaluation of the spillway capacity performed by the state as part of the original 1915 report on the dam. The small, rolling watershed is approximately rectangular in shape, except that the extreme upper portion is about twice as wide as the main part of the watershed. The watershed is about 2.0 miles long and averages about 1.2 miles wide, except for the upper portion which is about 2.3 miles wide. Elevations range from a high of about 1,470 at the upper reaches to the normal reservoir level of about 690. The watershed is about half wooded and half open/farmland with less than five percent residential development. While some residential development has recently occurred in the watershed, runoff characteristics are not expected to change significantly in the near future.

The 1915 "Report Upon Kunkles Dam" indicated that the spillway was 45 feet wide and three feet deep, values essentially verified by the field inspection. The coefficient of discharge for the weir was estimated to be 3.3 and, on that basis, the discharge capacity of the spillway was estimated to be 770 cfs, which was estimated to be 385 cfs per square mile of watershed, scarcely sufficient to meet the requirements of expected floods. As the surface area of the reservoir was considered large in relationship to the two square mile drainage area, the spillway capacity was compared to an estimated flood of 400 cfs per square mile. It was estimated that the reservoir would fill to the top of the embankment in one hour and 45 minutes, and that an additional depth of only 0.07 feet would be required to make the spillway capacity equal to the estimated runoff. Therefore, it was deemed that the spillway capacity, considered in connection with the storage capacity of the reservoir, was sufficient for probable floods. It is noted that this drainage area was reported to be two square miles, instead of the currently measured 2.4 square miles.

In accordance with criteria established by Federal (OCE) Guidelines, the recommended spillway design flood for this "Small" size dam and "Significant" hazard classification is the 100 Year Flood to one-half the Probable Maximum Flood (PMF). Based on the small capacity of the reservoir and the fact that no loss of life is likely during failure of this

structure, the 100 year event has been selected as the spillway design flood.

b. Experience Data. No reservoir level records or rainfall records are maintained for this dam by the Owner. During Tropical Storm Agnes, 1972, the reservoir level crested just below the tops of the spillway walls. As the Owner was concerned about overtopping the maximum section of the dam, efforts were made to lower the embankment at the junction of the embankment and left abutment. However, the rain stopped and the embankment was not lowered.

c. Visual Observations. At the time of the inspection, there were no conditions observed that would indicate a reduced spillway capacity during an extreme event. Other observations regarding the condition of the downstream channel, spillway and reservoir are located in Appendix A and discussed in greater detail in Section 3.

d. Overtopping Potential. The overtopping potential of this dam was estimated using the "HEC-1, Dam Safety Version" computer program. A brief description of the program is included in Appendix D. Calculations for this investigation indicate that a somewhat higher coefficient of discharge for the weir than previously used may be warranted, resulting in a maximum spillway capacity of 830 cfs. The 100 year peak inflow rate was calculated by the computer program as about 1,290 cfs. This value was checked against the peak inflow value as determined according to procedures contained in "Regional Frequency Study, Upper Delaware and Hudson River Basins, New York District", which resulted in an estimated peak inflow value of about 1,200 cfs. The computer program indicates that the 100 year event will overtop the embankment by about 0.8 foot for more than three hours.

e. Spillway Adequacy. The spillway for this structure is considered to be "Inadequate" as it will not pass the spillway design storm without overtopping the embankment.

f. Downstream Conditions. Immediately downstream of the dam to the right of the spillway is the Owner's cold storage building. At the left end of the dam immediately downstream is a garage that is not owned by the Owner of the dam. The second downstream damage center is located about 1,500 feet downstream of the dam, where the Owner's garage is expected to be flooded during failure of the dam. About 1,300 feet farther downstream is a house built on the floodplain, with a rear door about 2.5 feet above the channel bank. This house is not expected to be damaged during failure of the dam. There are no other houses within the next three miles that are

estimated to suffer damage as a result of failure of this dam during the 100 year storm. Commercial fish ponds about 4,000 feet downstream of the dam are expected to be flooded and possibly damaged during failure. Therefore, a "Significant" hazard potential classification is justified.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. Evidence of existing spillway instability detected by visual observations was limited to deterioration of the mortar joints of the spillway walls and dislocation of some stone. The upstream embankment slope has suffered the effects of wave action over the years, and large trees are growing on both the upstream and downstream embankment slopes. Considerable seepage was noted exiting the dam toe, both on the left and right of the spillway. In both directions, the amount of seepage decreased with increasing distance from the spillway. The Owner reported that about the same amount of seepage always exits the dam from the barrel near the right abutment, shown in Photograph 9. Seepage has been noted in state inspection reports since 1924. The description of the seepage over the years generally agrees with seepage observed on the date of the inspection. As no evidence of migration of fines through the embankment was noted, the seepage is assessed to represent a long-standing condition for this dam.

b. Design and Construction Data. No drawings exist for this structure, and construction data were extremely limited and were obtained principally in the state's original report on the dam in 1915, 45 years after the structure was completed. Thus, there are no stability analyses of the embankment in existence. The maximum height of the dam is about 21.4 feet above the stream bed elevation at the downstream toe. The upstream slope probably averages about 2H:1V, and the downstream slope ranges from 1.8H:1V to 2.0H:1V. Based on the geometric configuration of the embankment and the fact that a considerable part of the downstream section is constructed of rock, the embankment is assessed to be stable at this time, if not significantly overtopped.

Detrimental to the long-term stability of earthen embankments is the presence of extensive root systems within the embankments. The 1915 photographs of the dam taken by the state show large trees well established on both the upstream and downstream embankments. Thus, it is considered probable that the root systems are extremely extensive. The long-term stability of the embankment could be adversely affected when these trees die and the roots rot, forming channels for water to percolate through the dam. If the trees are allowed to fall over, large craters could be formed, possibly leading to a breach of the dam.

c. Operating Records. There are no operational records for this structure.

d. Post-Construction Changes. Post-construction modifications or changes include the replacement of the spillway after the 1895 failure and the construction of the downstream vertical wall near the location of the former sawmill. There are no records or evidence of modifications or post-construction changes to this dam since 1915, other than the installation of the chilled water line.

e. Seismic Stability. The dam is located in Seismic Zone 1. Normally it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake conditions. As the dam is qualitatively assessed to be stable at the present time under static loading conditions, it can reasonably be assumed to be stable under seismic loading conditions.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Evaluation. Visual inspection indicates that the dam and spillway structures of Kunkles Dam are currently in poor condition.

In accordance with criteria established by Federal (OCE) Guidelines, the recommended spillway design flood for this "Small" size dam and "Significant" hazard classification is the 100 Year Flood to one-half the Probable Maximum Flood (PMF). Based on the small capacity of the reservoir and the fact that no loss of life is likely during failure of the structure, the 100 year event has been selected as the spillway design flood.

Hydrologic and hydraulic computations presented in Appendix D indicate that the spillway structure is not capable of discharging the 100 year event without overtopping the embankment by about 0.8 feet for about 3.5 hours. The structure is considered to have an "Inadequate" spillway as it will not pass the spillway design flood without overtopping the embankment.

b. Adequacy of Information. The combined visual inspection and simplified calculations presented in Appendix D were sufficient to indicate that further investigations are required for this structure.

c. Urgency. It is recommended that the measures presented in Section 7.2 be implemented as specified.

7.2 Remedial Measures.

a. Facilities. It is recommended that the following measures be taken immediately. Items (1) through (4) should be performed under the supervision of a registered professional engineer experienced in the design and construction of dams.

(1) A detailed hydrologic/hydraulic study should be made and the spillway upgraded to meet current hydrologic/hydraulic criteria.

(2) A study should be made to determine the best method of removing trees without increasing potential

hazard of dam failure by piping through root channels.

(3) Seepage through the dam should be monitored for the development of turbidity and an increase in quantity.

(4) Damage to the upstream edge of the crest and the upstream embankment at the waterline should be repaired.

(5) The blowoff pipe through the spillway, the outlet pipe to the downstream sawmill and the chilled water line should be fitted at the upstream end with operational control devices.

(6) All joints of the spillway walls should be sealed to prevent further deterioration. Dislodged stones of the spillway wall should be replaced.

b. Operation and Maintenance Procedures. Because of the potential for property damage in the event of failure, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented for this facility. This procedure could be coordinated with local authorities and should include a method of warning downstream residents that high flows are expected. In addition, an operation and maintenance procedure should also be developed to insure that all pertinent items are carefully inspected on a regular basis and maintained in the best possible condition.

APPENDIX

A

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam *Kunkles Dam* County *Schuylkill* State *Pennsylvania* National ID # *PA 00669*

Type of Dam *Earth/rock* Hazard Category *Significant*

Date(s) Inspection *5/1/80* Weather *Sunny* Temperature *60's*

Pool Elevation at Time of Inspection *690.0*(1) M.S.L. Tailwater at Time of Inspection *672.2* M.S.L.

(1) *Assumed*

Inspection Personnel:

Mary F. Beck (Hydrologist)
Arthur H. Dvinoff (Geotechnical/Civil)
Raymond S. Lambert (Geologist)
Vincent McKeever (Hydrologist)
John H. Frederick (Geotechnical/Civil) *(5/16/80)*

Mary F. Beck Recorder

Remarks:

Mr. Harry N. Kunkle was on site and provided assistance to the inspection team.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	*N/A*	
STRUCTURE TO *ABUTMENT/EMBANKMENT* JUNCTIONS	*N/A*	
DRAINS	*N/A*	
WATER PASSAGES	*N/A*	
FOUNDATION	*N/A*	

CONCRETE/MASONRY DAMS

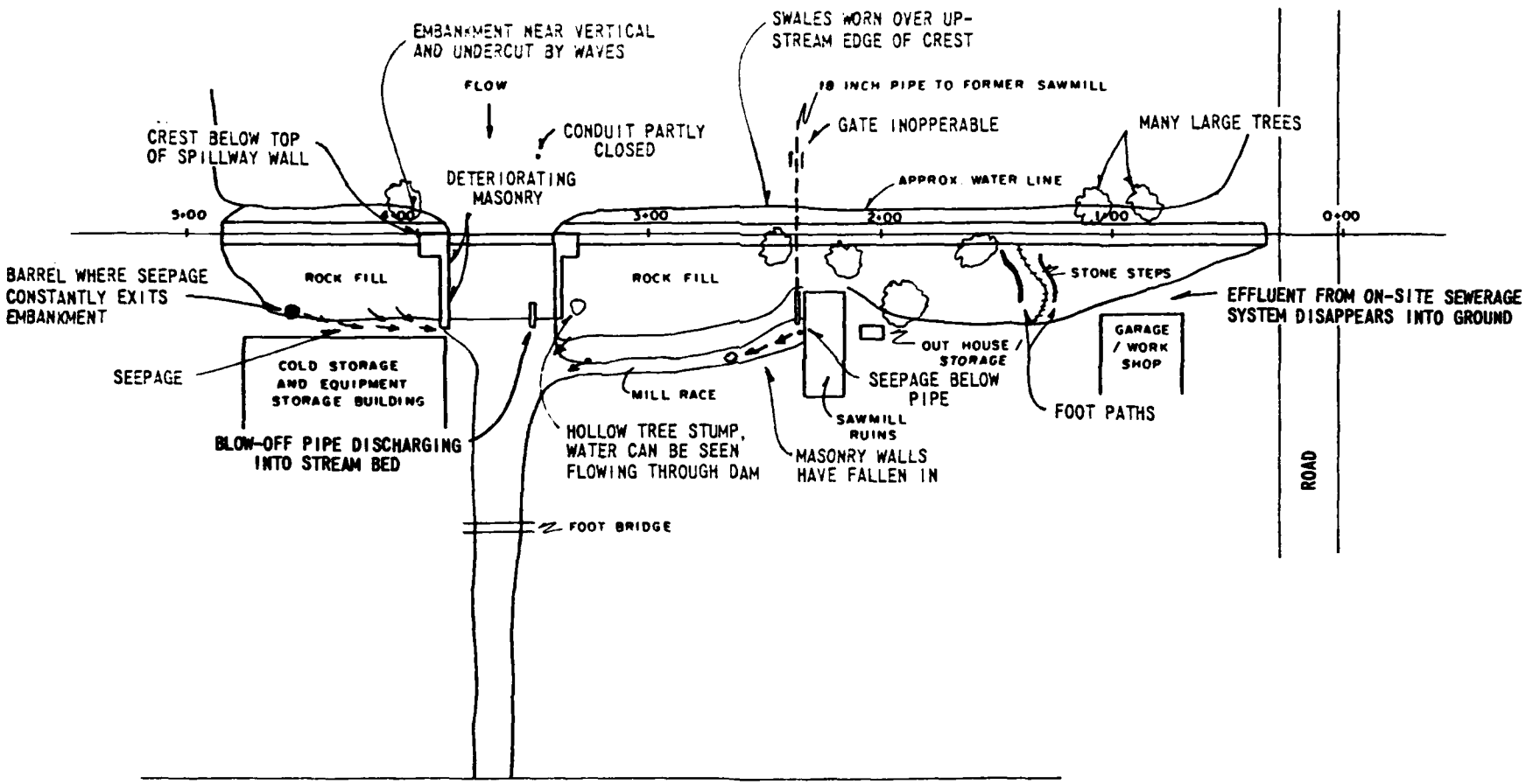
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	*N/A*	
STRUCTURAL CRACKING	*N/A*	
VERTICAL AND HORIZONTAL ALIGNMENT	*N/A*	
MONOLITH JOINTS	*N/A*	
CONSTRUCTION JOINTS	*N/A*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	*None observed.*	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	*None observed.*	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	*Upstream and downstream slopes have experienced erosion and foot traffic damage. Swales have been worn by foot traffic over the upstream edge of the crest.*	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	*Uneven, see Sheet 5B of 11.*	
RIPRAP FAILURES	*Yes, although shale is on upstream slope under water, the upstream slope is benched at the waterline with near vertical slopes and undercutting in some areas.*	

EMBANKMENT

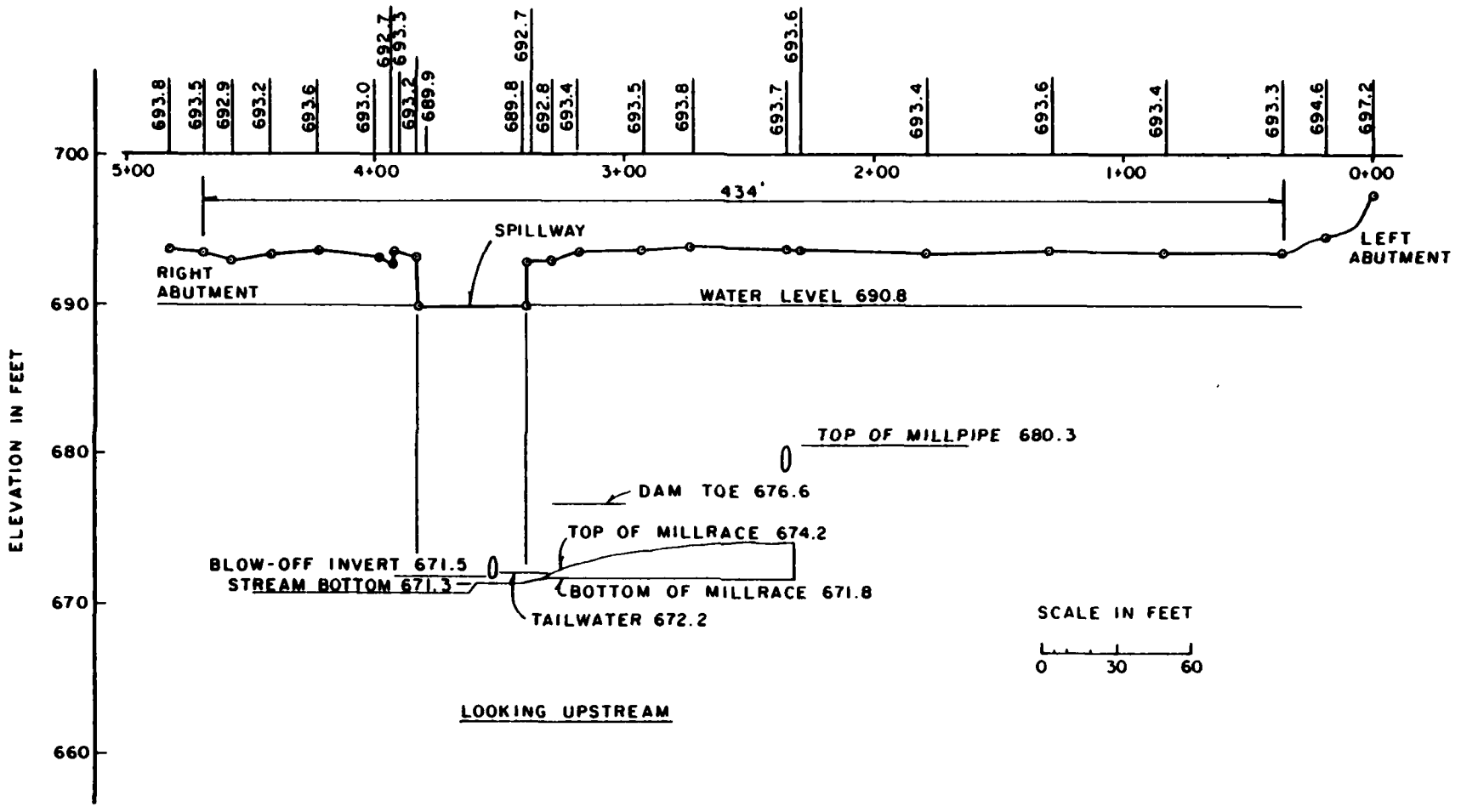
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	*Many large trees are growing on both upstream and downstream embankment slopes.*	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	*Good condition.*	
ANY NOTICEABLE SEEPAGE	*Yes, see Sheet 5A of 11. Seepage is considerable.*	
STAFF GAGE AND RECORDER	*None*	
DRAINS	*None*	



PA RT 443

FIELD OBSERVATION PLAN
KUNKLES DAM

SHEET 5A OF 11



FIELD OBSERVATION PROFILE
KUNKLES DAM

SHEET 5B OF 11

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	*N/A, consist of steel pipe to former downstream sawmill.*	
INTAKE STRUCTURE	*Upstream end under water, not completely closed by inoperable upstream gate.*	
OUTLET STRUCTURE	*Outlet conduit ends at turbine for former sawmill, which is in ruins.*	
OUTLET CHANNEL	*Mill race parallels dam toe from sawmill to stream channel. Stone walls have collapsed, partly blocking race.*	
EMERGENCY GATE	*A 24-inch pipe through spillway is supposed to be closed off at upstream end but had flow through it.*	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	*None, spillway constructed of rock with remnants of wooden weir.*	
APPROACH CHANNEL	*N/A*	
DISCHARGE CHANNEL	*Channel below dam approach in good condition with no significant bank cutting.*	
BRIDGE AND PIERS	*None*	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	*N/A*	
APPROACH CHANNEL	*N/A*	
DISCHARGE CHANNEL	*N/A*	
BRIDGE AND PIERS	*N/A*	
GATES AND OPERATION EQUIPMENT	*N/A*	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	*None*	
OBSERVATION WELLS	*None*	
WEIRS	*None*	
PIEZOMETERS	*None*	
OTHER	*None*	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	*The reservoir side slopes are steep and vegetated to the water's edge with trees. Very little debris noted.*	
SEDIMENTATION	*Considerable sediment at upper end has reduced normal surface area. Sediment is filling the lake.*	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	*The downstream channel is in good condition and is 10 to 15 feet wide with 2 to 4 foot high banks.*	
SLOPES	*The valley gradient below the dam is about 0.02.*	
APPROXIMATE NO. OF HOMES AND POPULATION	*About 1,000 feet below the dam is a house with four occupants. About 1,500 feet further downstream is a house built on the flood plain (back door about 2.5 feet above channel bank). Several fishing ponds are located about 1,300 feet further downstream.*	

APPENDIX

B

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM *Kunkles Dam*

ID # *PA 00669*

ITEM	REMARKS
AS-BUILT DRAWINGS	*None exist*
REGIONAL VICINITY MAP	*Plate 1, Appendix E.*
CONSTRUCTION HISTORY	*Section 1.2*
TYPICAL SECTIONS OF DAM	*Appendix E.*
OUTLETS - PLAN	*See Appendix E.*
DETAILS	
CONSTRAINTS	
DISCHARGE RATINGS	*Appendix D*
RAINFALL/RESERVOIR RECORDS	*None*

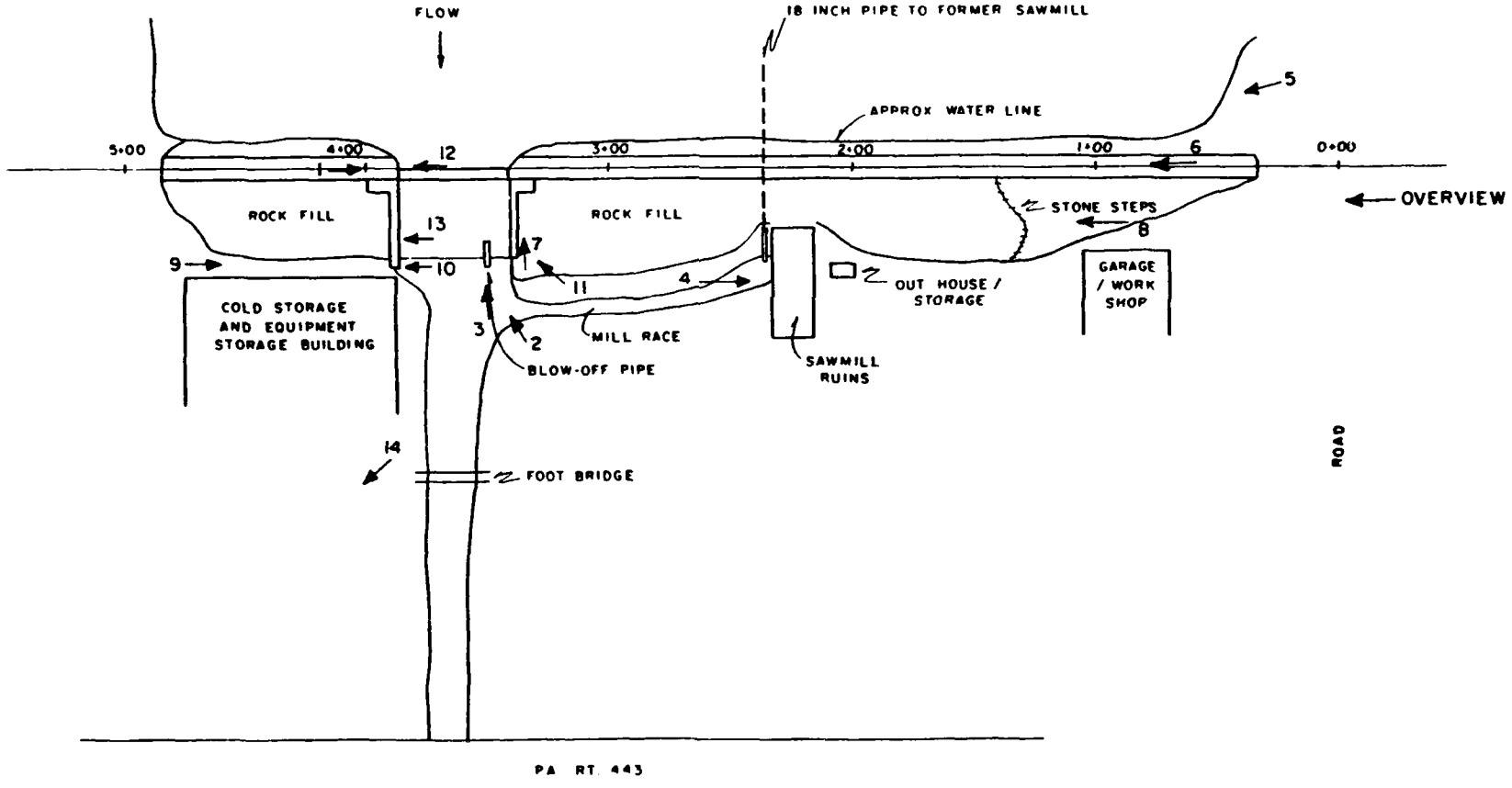
ITEM	REMARKS
DESIGN REPORTS	*None*
GEOLOGY REPORTS	*See Appendix F.*
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	*None*
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	*None*
POST-CONSTRUCTION SURVEYS OF DAM	*None*
BORROW SOURCES	*Unknown*

ITEM	REMARKS
MONITORING SYSTEMS	*None*
MODIFICATIONS	*Spillway replaced in 1895.*
HIGH POOL RECORDS	*None. Owner reported water level nearly 3 feet above spillway during Tropical Storm Agnes, 1972.*
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	*See Sheet 4 of 4, Miscellaneous*
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	*Partial failure of dam in 1895 because of insufficient spillway capacity. Spillway size increased, no other details known.*
MAINTENANCE OPERATION RECORDS	*None*

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	*See Appendix E.*
OPERATING EQUIPMENT PLANS & DETAILS	*None*
MISCELLANEOUS	*Information located in DER files includes:* 1. *Report upon the Kunkles Dam, dated April 15, 1915.* 2. *DER dam inspection reports.* 3. *Correspondence between DER and Owner.* 4. *10 black and white photographs.*

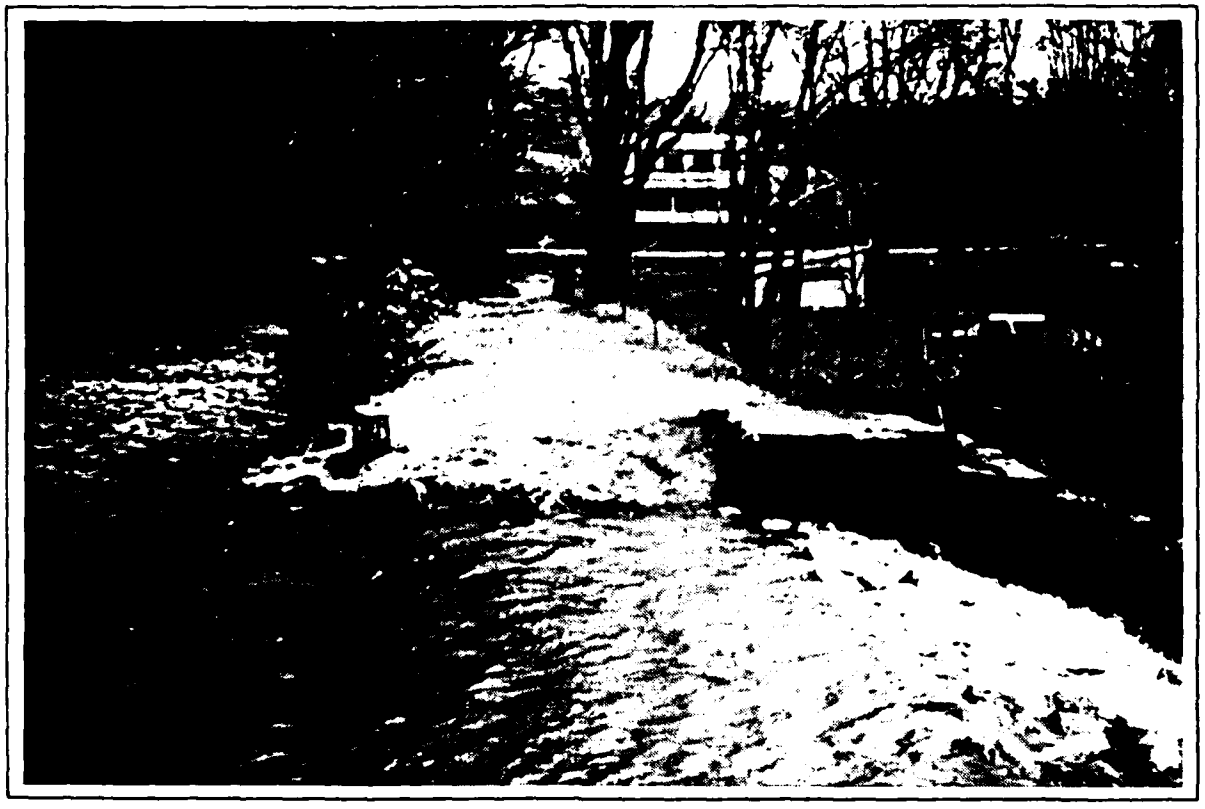
APPENDIX

C



PHOTOGRAPH LOCATION PLAN
KUNKLES DAM

PLATE C-1



VIEW FROM RIGHT SPILLWAY WALL.

PHOTOGRAPH NO. 1

ROCK SPILLWAY.

PHOTOGRAPH NO. 2

24 INCH PIPE THROUGH SPILLWAY.

PHOTOGRAPH NO. 3

TURBINE WHICH POWERED THE FORMER SAWMILL.

PHOTOGRAPH NO. 4

OVERALL VIEW OF UPSTREAM SLOPE.

PHOTOGRAPH NO. 5

VIEW OF CREST.

PHOTOGRAPH NO. 6

DOWNSTREAM VERTICAL WALL TO
THE LEFT OF THE SPILLWAY.

PHOTOGRAPH NO. 7

OVERALL VIEW OF DOWNSTREAM SLOPE
FROM LEFT ABUTMENT.

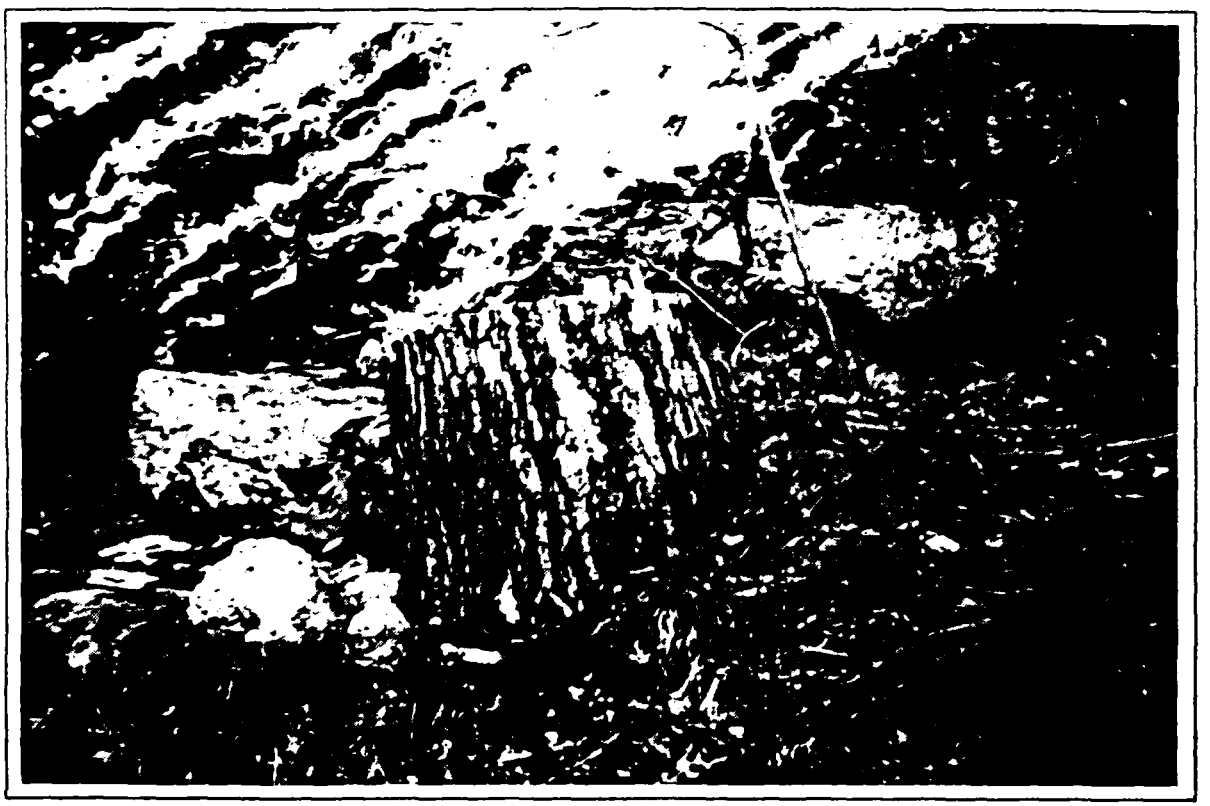
PHOTOGRAPH NO. 8

SEEPAGE ALONG TOE TO THE RIGHT
OF THE SPILLWAY.

PHOTOGRAPH NO. 9

SEEPAGE ON RIGHT SIDE OF
SPILLWAY JUST BEFORE
ENTERING SPILLWAY CHANNEL.

PHOTOGRAPH NO. 10



WATER FLOWING THROUGH DAM CAN BE
SEEN THROUGH HOLLOW STUMP.

PHOTOGRAPH NO. 11

DETERIORATION OF SPILLWAY WALL.

PHOTOGRAPH NO. 12

GENERAL DETERIORATION OF SPILLWAY.

PHOTOGRAPH NO. 13

FARM DOWNSTREAM OF DAM. HIGH DISCHARGES FLOW OVER ROADWAY.

PHOTOGRAPH NO. 14

HOUSE DOWNSTREAM OF DAM. DOOR OF HOUSE IS ABOUT 2.5 FEET ABOVE CHANNEL BANK.

PHOTOGRAPH NO. 15

APPENDIX

D

KUNKLES DAM
CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: *50% wooded, 50% open/farmland, little residential development.*

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): *689.8 feet (44 Acre-Feet).*

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): *692.7 feet (67 Acre-Feet).*

ELEVATION MAXIMUM DESIGN POOL: ------

ELEVATION TOP DAM: *692.7 feet.*

SPILLWAY

a. Elevation *689.8 feet.*

b. Type *Masonry, grouted near crest.*

c. Width *45 feet.*

d. Length *33± feet.*

e. Location Spillover *About 80 feet from right abutment.*

f. Number and Type of Gates *None*

OUTLET WORKS:

a. Type *18 inch pipe to sawmill.*

b. Location *About 200 feet from left abutment.*

c. Entrance inverts *Unknown.*

d. Exit inverts *678.7± feet at turbine*

e. Emergency draindown facilities *24 inch blow off pipe through spillway, upstream end partially blocked.*

HYDROMETEOROLOGICAL GAGES:

a. Type *None*

b. Location *N/A*

c. Records *N/A*

MAXIMUM NON-DAMAGING DISCHARGE: *Not determined.*

HYDROLOGIC AND HYDRAULIC BASE DATA

DRAINAGE AREA:(1) *2.4 square miles.*

100 YEAR PRECIPITATION(2)

30 Min.	*2.25 inches*
1 Hour	*2.80 inches*
2 Hours	*3.6 inches*
3 Hours	*4.0 inches*
6 Hours	*4.8 inches*
12 Hours	*5.8 inches*
24 Hours	*6.6 inches*

SNYDER HYDROGRAPH PARAMETERS:(4)

Zone	*6*
C_p, C_t	*0.40, 1.35*
L(5)	*2.82 miles*
Lca (6)	*1.32 miles*
$tp=C_t\ (L \cdot Lca)^{0.3}$	*2.00*

SPILLWAY CAPACITY AT MAXIMUM WATER LEVEL(7) *830 cfs*

---

(1) Measured from USGS maps.
(2) TP-40 - Rainfall Frequency Atlas of United States
(4) Information received from Corps of Engineers, Baltimore District.
(5) Length of longest water course from outlet to basin divide, measured from USGS maps.
(6) Length of water course from outlet to point opposite the centroid of drainage area, (see Plate 1, Appendix E) measured from USGS maps.
(7) See Sheet 9 of this Appendix.

HEC-1, REVISED
FLOOD HYDROGRAPH PACKAGE

The original "Flood Hydrograph Package" (HEC-1), developed by the Hydrologic Engineering Center, Corps of Engineers, has been modified for use under the National Dam Inspection Program. The "Flood Hydrograph Package (HEC-1), Dam Safety Version", hereinafter referred to as, HEC-1, Rev., has been modified to require less detailed input and to include a dam breach analysis. The required input is obtained from the field inspection of a dam, any available design/evaluation data, relatively simple hydraulic calculations, or information from the USGS Quandrangle maps. The input format is flexible in order to reflect any unique characteristics of an individual dam.

HEC-1, Rev. computes a reservoir inflow hydrograph based on individual watershed characteristics such as: area, percentage of impervious surface area, watershed shape, and hydrograph characteristics determined from regional correlation studies by the Corps of Engineers, Baltimore District. The inflow is routed through the reservoir using spillway discharge data obtained from the field inspection or design data. Flood storage capacity is determined from USGS maps or design information and verified by the field inspection. In the event a spillway cannot discharge 0.5 PMF without overtopping and failure of the dam, downstream channel characteristics obtained from the field inspection and USGS maps are inputed and flows are routed downstream to the damage center and a dam breach analysis is performed.

Included in this Appendix are the HEC-1, Rev. pertinent input values and a summary print-out tables.

BY MEB DATE 5/22/90 SUBJECT Kunkles Dam SHEET 4 OF 9

CHKD. BY AHD DATE 5/23/90 Hydrology / Hydraulics JOB No.

Classification (Ref. Recommended Guidelines for Safety Inspection of Dams)

1. The hazard classification is rated as "Significant" as there would be economic loss and possible loss of life in the event of failure.

2. The size classification is "Small" based on its less than 40 ft. height and 67 Ac-Ft. total storage capacity.

3. The selected spillway design flood, based on size and hazard classification, is the 100 yr. event.

Hydrology and Hydraulic Analysis

1. Original data. There is no original data. Subsequent evaluation data is contained in the State's 1915 report on the dam. Spillway size: 45 ft x 3 ft.
   Coefficient of discharge: 3.3
   Discharge: $Q = CLH^{3/2} = 790$ cfs
   The State accessed "that the spillway capacity, considered in connection with the storage capacity of the reservoir, is sufficient to take care of probable floods."

2. Evaluation data.
   Rainfall and Snyder's Hydrograph parameters are shown on sheet 2. The value of the peak inflow value is checked against the peak 100 yr. inflow value (Q_{100}) determined by procedures contained in "Regional Frequency Study, Upper Delaware and Hudson River Basins, New York District."

$$\log(Q_m) = C_m + 0.87 \log(D.A.)$$

where $C_m = 1.7$ from fig. 2 ✓

D.A. = 2.4 sq. mile from sheet 2

$\log(Q_m) = 2.03$ ✓

$$S = C_s - 0.05 \log(D.A.)$$

where $C_s = 0.41$ ✓ from fig. 3

$S = 0.39$ ✓

$q = +0.5$ from fig 5 ✓

$\log(Q_{100}) = \log(Q_m) + k(P,g)S$
where $k(P,g) = 2.69$ from table ✓
$\log(Q_{100}) = 2.03 + 2.69 \cdot 0.39$
$= 3.08$ ✓
$Q_{100} = 1200$ cfs ✓

Elevation - storage Data. Areas were measured from USGS map. Normal Pool (689.8) = 7.4 Ac
700 ft contour = 11.9 Ac
Computer program computes volume.

Elevation - discharge Data is shown on sheet 8
$Q = C L H^{3/2}$
where L = 45 ft. field checked
C = 3.7 (est.) Ref. Table 5-8
King & Brater. Hand b'k of Hydraulics, 2 ed.

3. Results of computer analysis. The peak inflow (Q_{100}) calculated by the HEC-1 program is 1289 cfs, within 8% of the value for Q_{100} calculated above. The program indicates the dam will be overtopped by the 100 yr event. Tropical Storm Agnes (June 1972) is reported to have approached the top of the dam but did not overtop it. About 8 inches of rain fell between June 20 to 25th. The closest U.S. reporting rain gaging station is at Port Clinton, about 7 miles south of the dam. Rainfall amounts are missing for the 22nd & 23rd, the days of maximum rainfall. Berne is the station closest to Port Clinton, which reported 5.9 inches in one day.

4. Spillway Adequacy - the spillway is considered "Inadequate" as it will not pass the selected spillway design storm without overtopping the dam.

```
1**********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  26 FEB 79
 **********************************

 RUN  DATE* 80/05/13.
      TIME* 06.19.34.
```

KUNKLES DAM
NAT ID NO. PA 00669 DER NO. 54-67
OVERTOPPING ANALYSIS

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	15	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 1 LRTIO= 1

RTIOS= 1.00

SHEET 6 OF 9

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
IN	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	1	2.40	0.00	2.40	1.00	0.000	0	1	0

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	.10	.00	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 2.00 CP= .40 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 84 END-OF-PERIOD ORDINATES, LAG= 2.01 HOURS, CP= .40 VOL= 1.00

12.	45.	92.	147.	206.	257.	294.	315.	312.	294.
275.	257.	240.	224.	210.	196.	183.	171.	160.	150.
140.	131.	122.	114.	107.	100.	94.	87.	82.	76.
71.	67.	62.	58.	55.	51.	48.	45.	42.	39.
36.	34.	32.	30.	28.	26.	24.	23.	21.	20.
19.	17.	16.	15.	14.	13.	12.	12.	11.	10.
9.	9.	8.	8.	7.	7.	6.	6.	6.	5.
5.	5.	4.	4.	4.	3.	3.	3.	3.	3.
2.	2.	2.	2.						

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	6.54	6.42	.12	39613.
										(166.)(163.)(3.)(1121.72)			

0 96 ASSUMED RAINFALL DISTRIBUTION

01.016	.016	.016	.016	.016	.016	.016	.016	.016	.016
01 .016	.016	.016	.016	.016	.016	.016	.0166	.016	.016
01 .016	.016	.024	.024	.04	.04	.04	.04	.04	.04
01.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
01 .04	.04	.04	.04	.04	.04	.06	.06	.06	.06
01 .06	.06	.06	.06	.06	.06	.2	.2	.2	.2
01.275	1.125	1.125	.275	.1	.1	.1	.1	.07	.07
01 .06	.06	.024	.024	.016	.016	.016	.016	.016	.016
01 .016	.016	.016	.016	.016	.016	.016	.016	.016	.016
01 .016	.016	.016	.016	.016	.016				

HYDROGRAPH ROUTING

OUTFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
OUT	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-690.	-1

STAGE	689.80	691.00	692.00	693.00	694.00	696.00	698.00
FLOW	0.00	219.00	543.00	953.00	1433.00	2570.00	3910.00
SURFACE AREA=	0.	7.	12.				
CAPACITY=	0.	44.	141.				
ELEVATION=	672.	690.	700.				

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
689.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
692.7	0.0	0.0	0.

CREST LENGTH AT OR BELOW ELEVATION	0. 692.7	7. 693.0	120. 693.5	410. 694.0	425. 695.0

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

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00
HYDROGRAPH AT	IN	2.40 (6.22)	1	1289. (36.49)(
ROUTED TO	OUT	2.40 (6.22)	1	1277. (36.17)(

SUMMARY OF DAM SAFETY ANALYSIS

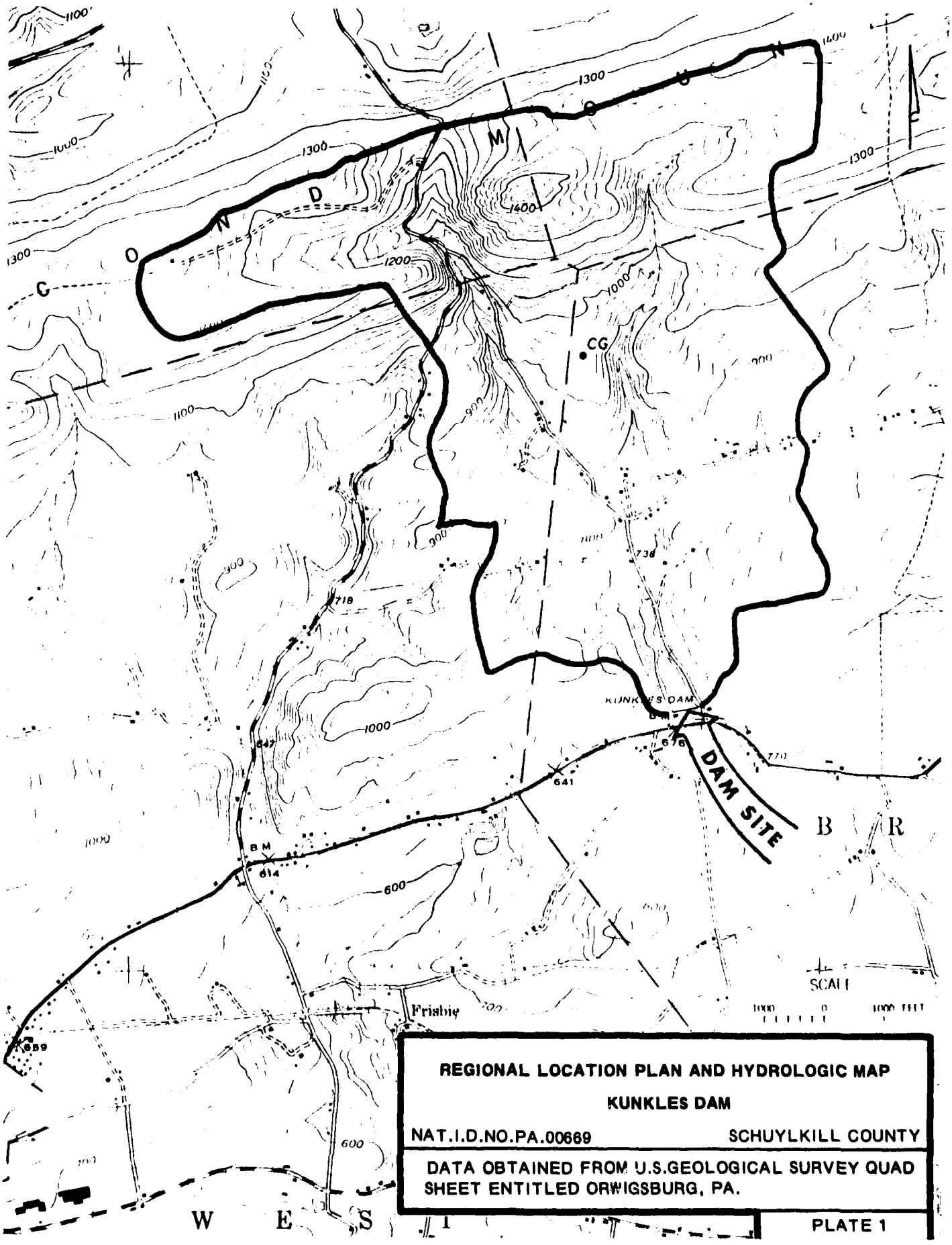
	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	689.80	689.80	692.70
STORAGE	44.	44.	67.
OUTFLOW	0.	0.	830.

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
1.00	693.54	.84	74.	1277.	3.50	17.75	0.00

SHEET 9 OF 9

APPENDIX

E



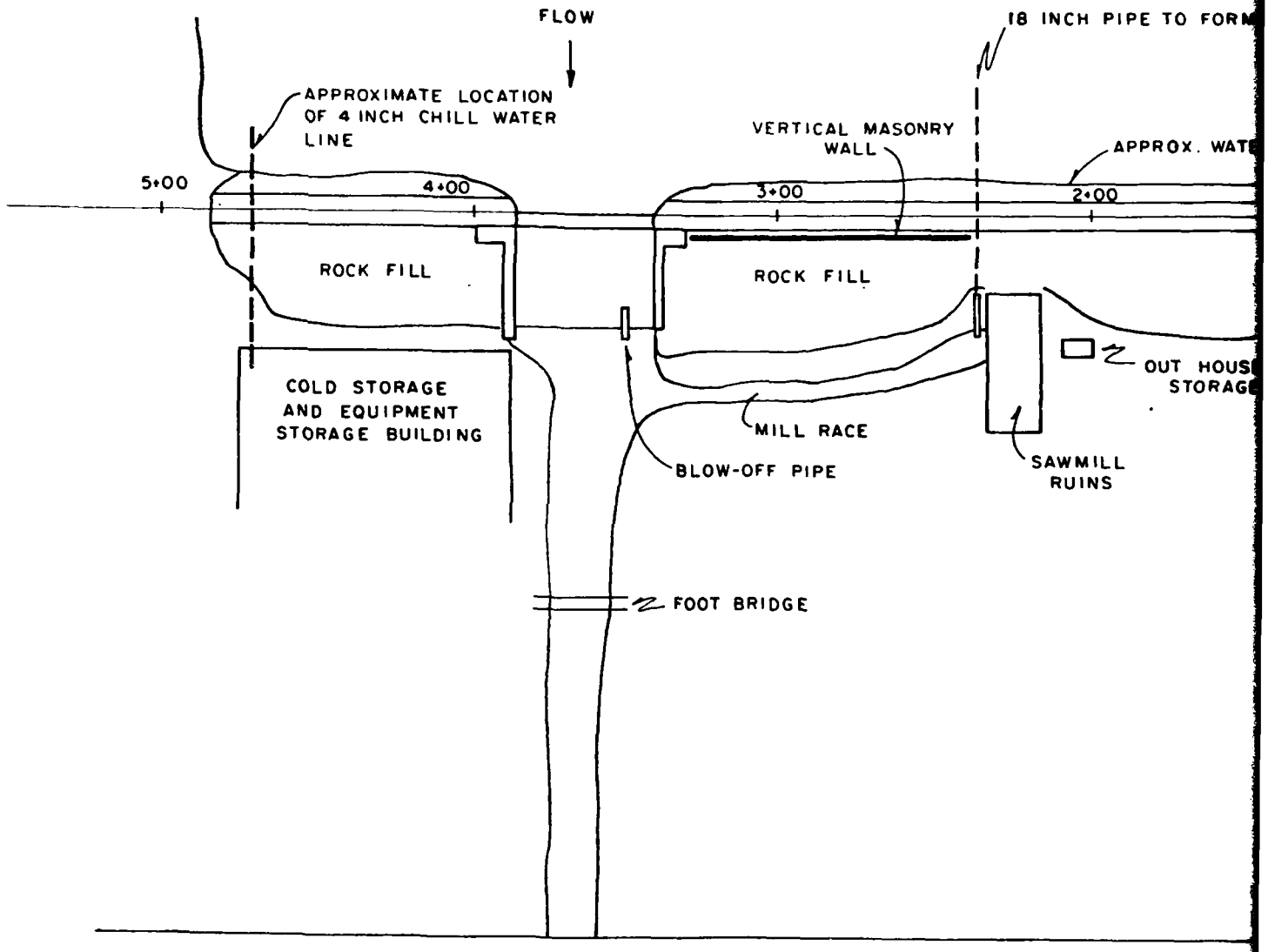
REGIONAL LOCATION PLAN AND HYDROLOGIC MAP

KUNKLES DAM

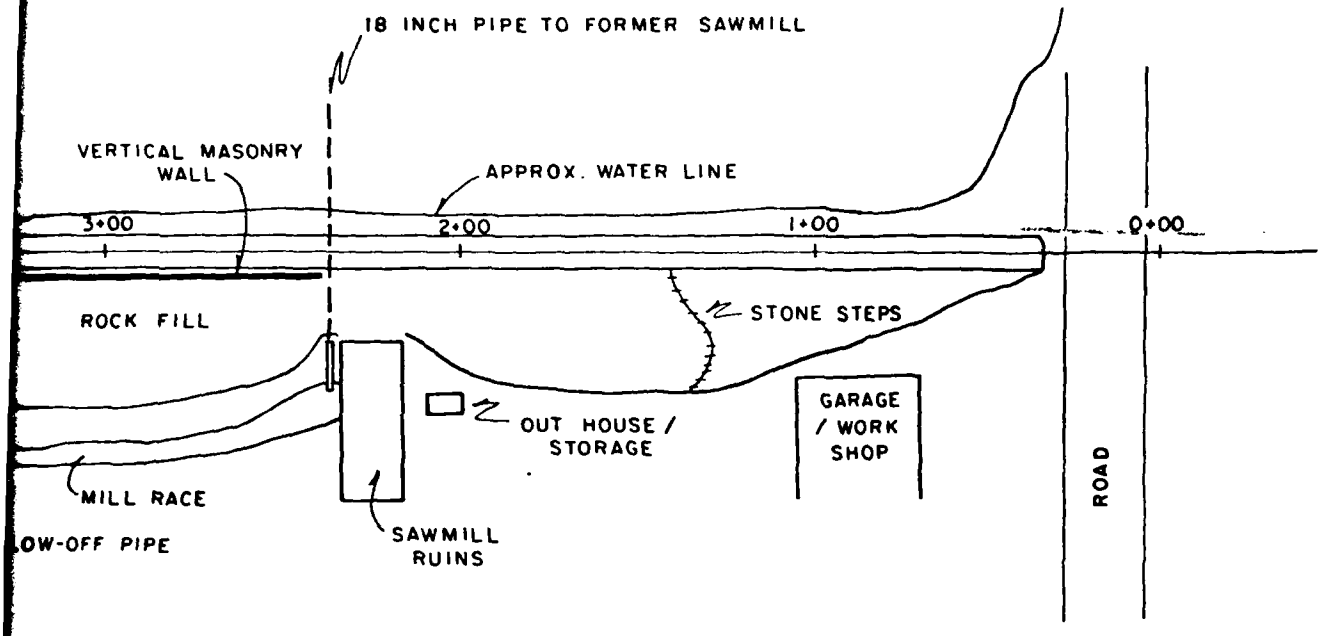
NAT.I.D.NO.PA.00669 SCHUYLKILL COUNTY

DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY QUAD SHEET ENTITLED ORWIGSBURG, PA.

PLATE 1


FLOW
18 INCH PIPE TO FORM
APPROXIMATE LOCATION OF 4 INCH CHILL WATER LINE
VERTICAL MASONRY WALL
APPROX. WATE
5+00
4+00
3+00
2+00
ROCK FILL
ROCK FILL
COLD STORAGE AND EQUIPMENT STORAGE BUILDING
OUT HOUSE STORAGE
MILL RACE
BLOW-OFF PIPE
SAWMILL RUINS
FOOT BRIDGE

PA. RT. 443



OT BRIDGE

SCALE IN FEET

0 25 50

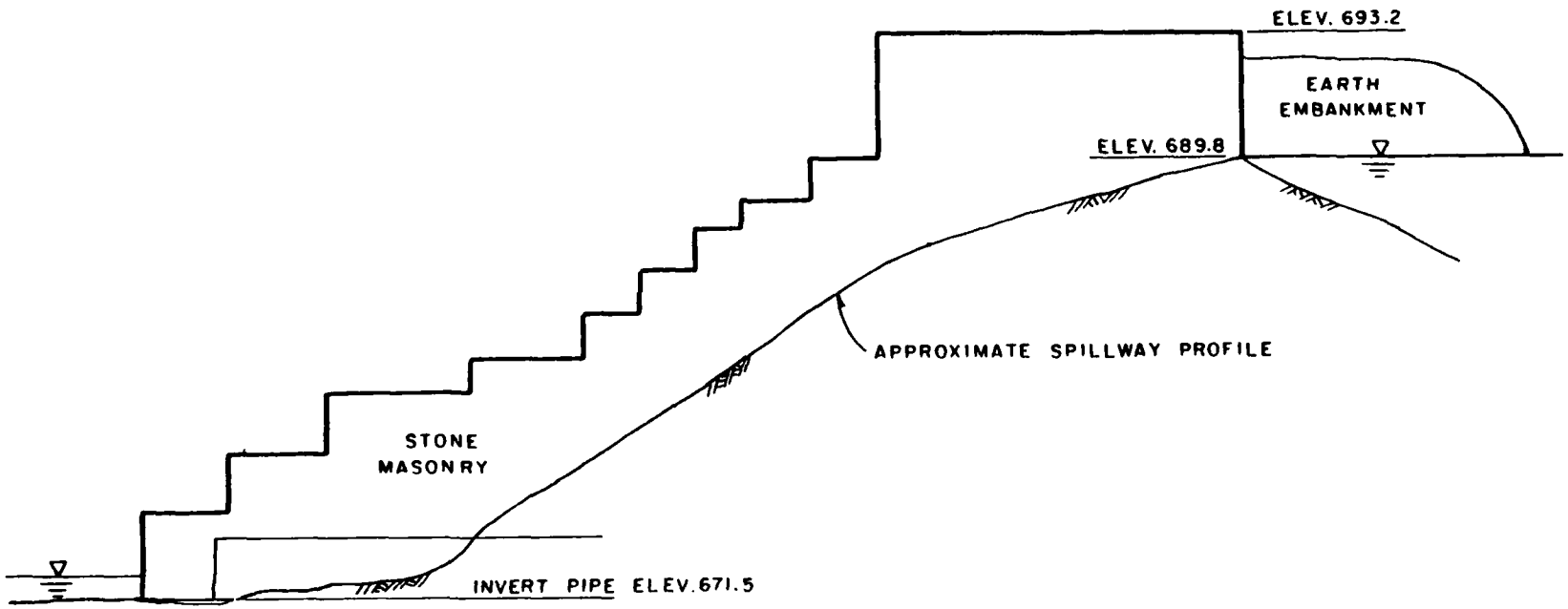
A. RT. 443

DATA OBTAINED FROM MEASUREMENTS TAKEN ON 5/1/80

PLAN OF DAM
KUNKLES DAM

PLATE 2

2



DATA OBTAINED FROM MEASUREMENTS
TAKEN ON 5/1/80

SCALE IN FEET

0 3 6

SECTION THROUGH SPILLWAY
KUNKLES DAM

PLATE 3

APPENDIX

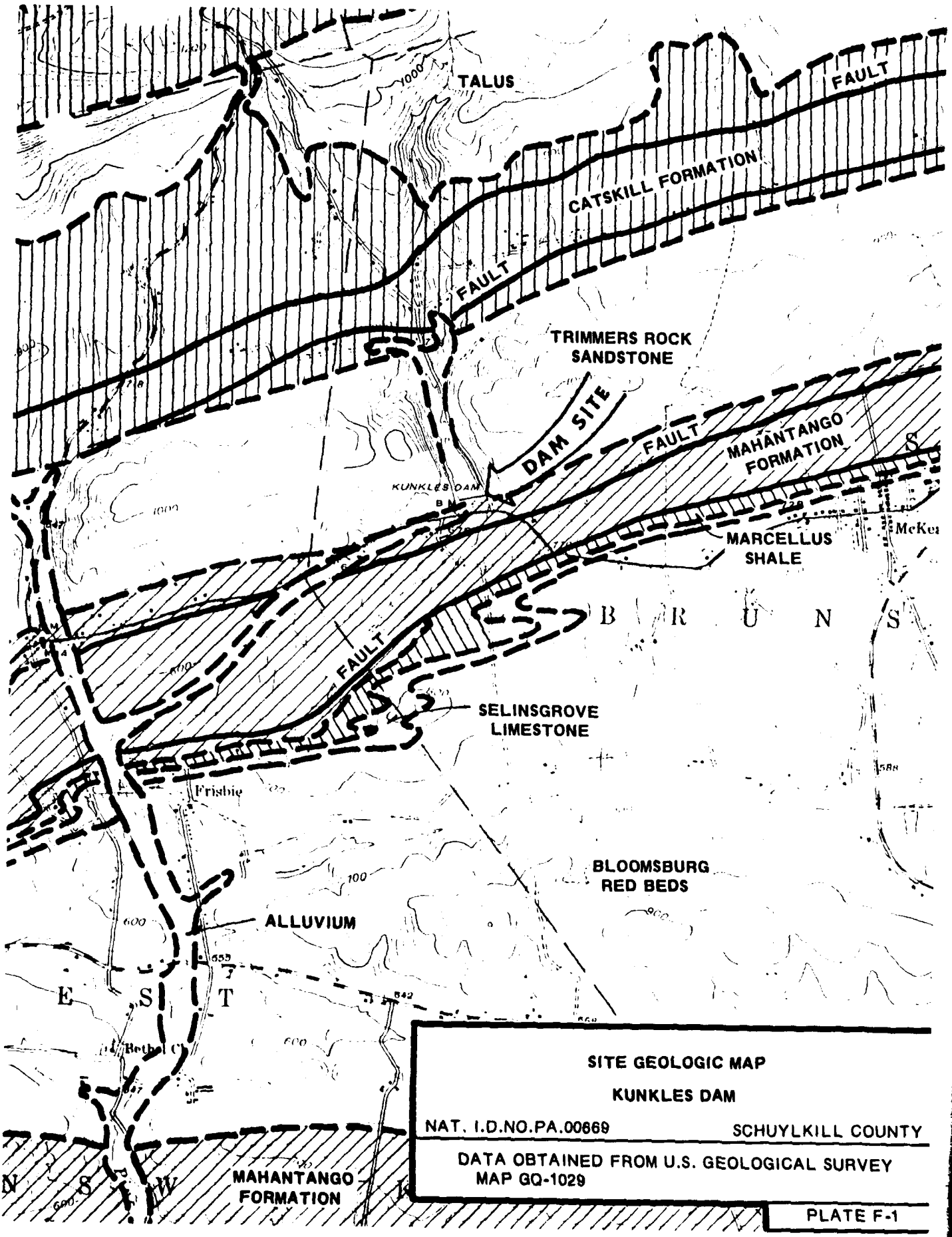
F

SITE GEOLOGY
KUNKLES DAM

Kunkles Dam is located in the Appalachian Mountain Section of the Valley and Ridge Physiographic Province. As shown on Plate F-1, the dam is constructed upon the Devonian age Trimmers Rock Sandstone Formation near the contact with the underlying shale of the Mahatango Formation. Bedrock is exposed along the hillside adjacent to the right abutment of the dam. Here the green-gray, well bedded, sandy siltstones, siltstones and shales strike approximately east-west to east-northeast, nearly parallel to the dam centerline. At the right abutment, the bedrock dips downstream (south) at a high angle. The axis of a small east-west trending syncline (downfold) is located approximately coincident with the downstream toe of the dam. Thus, the direction of bedding dip changes from south to north downstream of the dam.

High angle to near vertical jointing is well developed. The predominant strike of the joints is almost north-south and north-northwest (approximately perpendicular to the dam centerline).

The high angle downstream direction of bedding dip would be a factor expected to minimize seepage potential, but the nearness of bedrock to the ground surface and the open, near vertical joints which cross the dam centerline would be factors favoring potential seepage. The seepage observed at the right side along the dam toe may thus be related to the above mentioned bedrock conditions.



SITE GEOLOGIC MAP

KUNKLES DAM

NAT. I.D.NO.PA.00669 SCHUYLKILL COUNTY

DATA OBTAINED FROM U.S. GEOLOGICAL SURVEY MAP GQ-1029

PLATE F-1


DATE
FILME
8