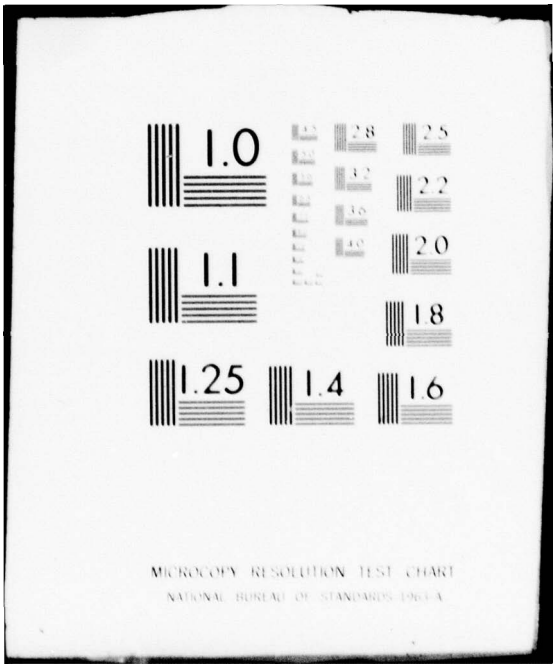
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Hutchinson Reservoir Dam No. 2

NDI # PA - 215

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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PREPARED FOR

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

PREPARED BY

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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 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 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. In cases where the reservoir was lowered (as was Hutchinson Reservoir No. 2) 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.

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PHASE I REPORT
National Dam Inspection Program

ABSTRACT

Hutchinson Reservoir Dam No. 2: NDS I.D. No. PA-00215

Owner: Western Pennsylvania Water Company

State Located: Pennsylvania (PennDER I.D. No. 26-14)

County Located: Fayette County

Stream: Redstone Creek

Inspection Date(s): October 6, 1978

Inspection Team: GAI Consultants, Inc.
570 Beatty Road
Monroeville, Pennsylvania 15146

The visual inspection, operational history, and hydrologic and hydraulic analysis indicate that the structure is in poor condition. Obvious downstream movement of the embankment crest, slump features on both the upstream and downstream slopes, inexplicable probing and grouting on the downstream slope, and evidence of clay plugs within the exposed reservoir surface are indicative of past stability and seepage problems.

Based on recommended guidelines, it has been determined that the spillway design flood (SDF) for this facility is the probable maximum flood (PMF). Hydrologic and hydraulic calculations indicate that the existing spillway system can pass only 27 percent of the PMF prior to overtopping of the dam. Under 1/2-PMF conditions it has been determined that the embankment will be overtopped leading to failure and potential increase in the hazard to loss of life downstream. As the hazard rating of the facility is "high", the present spillway condition is assessed as being "seriously inadequate".

The inadequacies of the spillway and apparent instability of the embankment are deficiencies of such a nature that if left uncorrected could result in the failure of the dam with subsequent increase in the potential for loss of life and/or substantial property damage. Thus, the facility is considered unsafe.

The pool level has been lowered by order of PennDER and failure does not appear imminent under the conditions which

existed at the time of the field inspection; however, due to the serious inadequacy of the spillway, a detailed emergency operation plan and warning system should be immediately activated which includes around-the-clock surveillance by a professional engineer experienced in the design and performance evaluation of earth structures during periods of unusually heavy precipitation.

It is recommended that the owner:

1. Perform a detailed subsurface evaluation to assess the condition and properties of the embankment and underlying materials.

2. Perform a detailed hydrologic and hydraulic evaluation of the facility including an assessment of downstream effects should a decision be made to breach or remove the embankment from the Hutchinson Dam System.

3. Perform a stability and seepage evaluation of the embankment under all possible operating conditions utilizing the results of Item 1, above.

4. Take appropriate remedial actions based on the results of the above analyses.

5. Install valving mechanisms on the upstream ends of both the supply line and blowoff conduit so as to establish flow control at the inlets.

6. Immediately activate a plan for emergency operation and a warning system for downstream residents. Included in the plan should be provisions for around-the-clock surveillance of the facility by a professional engineer experienced in the design and performance evaluation of earth structures during periods of unusually heavy precipitation.

7. Maintain the drawn down status of the pool level as directed by PennDER until final hydrologic/hydraulic and structural assessments are made on the facility.

8. Formalize a maintenance program that provides for the proper and adequate care of this facility, including, but not limited to, the removal of excess brush and overgrowth from the embankment crest and slopes.

BMM/lmb

GAI Consultants, Inc.

Bernard M. Mihalcin

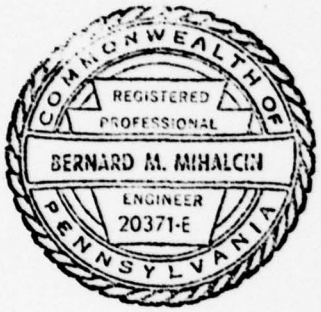
Bernard M. Mihalcin, P.E.

Date 9 FEB 1979

Approved by:

C. K. WITHERS
Colonel, Corps of Engineers
District Engineer

Date 4 Mar 79




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Overview Photograph of Hutchinson Reservoirs Nos. 1, 2, and 3

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
HUTCHINSON RESERVOIR DAM NO. 2
NDI# PA-215, PENNDER# 26-14

## SECTION 1
## GENERAL INFORMATION

### 1.0 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.

### 1.1 Purpose.

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

### 1.2 Description of Project.

a. Dam and Appurtenances. Hutchinson Reservoir Dam No. 2 is an earth embankment approximately 560 feet in length with a maximum height of 47 feet. According to available information, the structure was constructed with a concrete core wall that extends across its length from just beneath the crest to a depth 13 feet below the original ground surface. Both the upstream and downstream slopes are covered with hand-placed sandstone riprap. The downstream slope is interrupted by two berms, the lower of which is used as a private road that provides access to the caretaker's residence, as well as to Hutchinson Reservoir Dam No. 1.

The dam lies in a general east to west direction. The design of the facility required that fill be placed along the west shore in order to bring a low area that adjoins a neighboring watershed to grade. Consequently, a small saddle dam was constructed as an extension of the main embankment along the west side of the reservoir. The saddle dam is roughly perpendicular to the main embankment centerline and is approximately 350 feet in length (see Photograph 5 and Figure 3). The inside face is a near vertical, hand-placed rock masonry wall that varies from 8 to 12 feet high. The crest is wide, extending approximately 50 feet at the maximum section. The outside face has no clearly discernible features, and slopes gently into the natural ground surface.

The facility is served by a concrete chute spillway located along the left side of the main embankment. Other appurtenances include a 12-inch diameter cast-iron supply pipe which bypasses the lower reservoir and can be operated independently and a 14-inch diameter cast-iron blowoff pipe which empties into the stream at the toe of Dam No. 2. Both pipes are valved at the downstream toe.

b. Location. Hutchinson Reservoir Dam No. 2 is located on Redstone Creek approximately 1.5 miles south of Hopwood, Fayette County, Pennsylvania. The dam, reservoir, and watershed are contained on the Brownfield, Pennsylvania, 7.5 minute U.S.G.S. quadrangle. The coordinates of the dam are N39° 51.0' and N79° 42.0'.

c. Size Classification. Intermediate (47 feet high, storage capacity 136 acre-feet at top of dam).

d. Hazard Classification. High (see Section 3.1.e).

e. Ownership. Western Pennsylvania Water Company
Uniontown District
72 Coolspring Street
Uniontown, Pennsylvania 15401

f. Purpose. Domestic water supply.

g. Historical Data. According to available records, Hutchinson Reservoir Dam No. 2 was built in 1903 to serve as a water supply impoundment in conjunction with Hutchinson Reservoir Dam No. 1 situated approximately 1/4 mile downstream. Available Pennsylvania State Inspection reports, dated 1914 through 1961, reveal significant deficiencies developed over the years with regard to this facility. As early as 1914, the original spillway was found to be inadequate and was replaced in 1915 with the present spillway. Seepage has been consistently reported emanating from the left abutment hillside and along the downstream toe near the original streambed. The amount of seepage observed has always been considered minor; consequently, no investigations were performed to determine its origin and nature. The most significant deficiency associated with Hutchinson Reservoir Dam No. 2 was first reported in 1929. It involved the inspector's observation of an uneven crest and apparent slipping of the upstream face. Subsequent inspections in 1930 and 1933 reiterated the contention that the upstream slope was slowly slipping. In later years, the slopes apparently stabilized as suggested in the last available report dated 1961 which stated that the general condition was "o.k.". Based on the observations reported in 1961, the overall condition of the facility has steadily deteriorated over the last 17 years.

1.3 Pertinent Data.

a. Drainage Area. Local ≈ 0.09 sq. miles (No. 2 Dam only)
Total ≈ 2.0 sq. miles (Dams 2 and 3 inclusive)

b. Discharge at Dam Site. Discharge records are not available. The owner's representatives could not recall with any certainty the maximum spillway discharge to date.

Outlet Conduit at Operating Pool Elevation - Discharge curve not available.

Emergency Spillway Capacity at Top of Dam Pool ≈ 380 cfs.

c. Elevation (feet above mean sea level).

Top of Dam ≈ 1347.6.

Maximum Design Pool - Not known.

Maximum Pool of Record - Not known.

Normal Pool ≈ 1345.8.

Emergency Spillway Crest ≈ 1345.8.

Upstream Portal Outlet Invert ≈ 1311 (rough estimate).

Downstream Portal Outlet Invert ≈ 1304 (rough estimate).

Streambed at Dam Centerline ≈ 1307 (rough estimate).

Maximum Tailwater - Not known.

d. Reservoir Length (miles).

Maximum Pool ≈ 0.2 (elevation 1347.6).

Normal Pool ≈ 0.2 (elevation 1345.8).

e. Storage (acre-feet).

Emergency Spillway ≈ 121 (elevation 1345.8).

Top of Dam ≈ 136 (elevation 1347.6).

Design Surcharge - Not known.

f. Reservoir Surface (acres).

Emergency Spillway ≈ 8.0 (elevation 1345.8).

Top of Dam ≈ 8.6 (elevation 1347.6).

Maximum Design Pool - Not known.

g. Dam.

Type - Earthen embankment built with hand-placed riprap slopes and a concrete core wall.

Length ≈ 560 feet (excluding saddle dam extension adjacent to left abutment).

Height ≈ 47 feet.

Top Width ≈ 12 feet (field measured),
28 feet (as per Figure 3)

Side Slopes - Upstream ≈ 2H:1V to 1H:1V (varies)
Upper Downstream ≈ 2H:1V to 1.5H:1V (varies)
Middle Downstream ≈ 1/2H:1V
Lower Downstream ≈ 1H:1V

Zoning - None indicated.

Impervious Core - A concrete core wall with a 2.5-foot constant thickness is indicated by the drawings (see Figure 3) to extend across the length of the embankment and is carried to a depth of approximately 13 feet below the original ground surface.

Cutoff - The concrete core wall serves as the only cutoff.

Grout Curtain - None indicated.

h. Outlet Conduit.

Type - 12-inch diameter cast-iron supply line
14-inch diameter cast-iron blowoff line

Length ≈ 190 feet (upstream inlet to valve at downstream toe).

Closure - Both lines are valved at the downstream toe of the embankment. The valves are manually operated.

Access - The valves are located in a clear area above ground and are readily accessible.

Regulating Facilities - 14-inch diameter and 12-inch diameter gate valves regulate the flows through the blowoff conduit and supply line, respectively, from their positions at the downstream toe. The supply line is also regulated at several downstream locations.

i. Spillway.

Type - Uncontrolled concrete chute spillway located on the left side of the embankment.

Weir Length ≃ 50.7 feet.

Crest Elevation ≃ 1345.8.

Downstream Channel - Flow discharged through the emergency spillway passes into a narrow channel having three-foot high sidewalls (see Photograph 10), and is directed over the lower left abutment hillside and into the stream immediately beyond the embankment toe (see Photographs 8 and 11).

j. Regulating Outlets. Gate valves regulate flow through both the 12-inch supply line and 14-inch diameter blowoff. Both valves are located at the downstream toe of Dam No. 2.

## SECTION 2
## ENGINEERING DATA

### 2.1 Design.

a. Design Data Availability and Sources.

No design reports are available for any aspect of this facility. Design features, presented below, are derived from two drawings, historical accounts and inspection reports, and discussions with the owners' representatives.

b. Design Features.

1. Embankment. Very limited information is available relative to the original design of this facility. Available drawings indicate the embankment was constructed of earth with a concrete core wall. Placement and compaction procedures are unknown.

The earliest descriptive report pertaining to the facility is dated September 30, 1914, entitled "Report Upon the Hutchinson Dam No. 2 of the Uniontown Water Company." The report was issued 11 years after construction and contains data relative to the pertinent dimensions of the original facility.

> "The top of the dam has a width of 28 feet and has a slope of about 4 feet in it away from the reservoir. The upper face has a slope of 1 vertical on about 1-1/2 horizontal and is lined with a dry rubble wall. The downstream face is made up of three slopes and two berms. The first slope at the top of the embankment is 14 feet high and slopes 1 on 1. Below this slope is a berm of 20 feet and then the bank slopes off 10 feet vertically in a length of 7 feet horizontally. Below this is a second berm 16 feet wide and below this the bank slopes 9 feet vertically in 15 feet horizontally. The slopes are all protected by dry rubble walls. A private road is carried across the lower berm."

2. Appurtenant Structures.

a) Outlet Works. The outlet works serving Hutchinson Reservoir Dam No. 2 consists of two cast-iron pipes (supply and blowoff) carried through the dam. The supply pipe is a 12-inch diameter line that passes around the right side of Reservoir No. 1 within an adjacent raceway. Reportedly, the supply line from Reservoir No. 2 is only used on those occasions when the Reservoir No. 1 is shut down. The blowoff pipe is a 14-inch diameter line that empties into the stream channel at the toe of Dam

No. 2, and is carried into Reservoir No. 1. Both lines are equipped with gate valves at the downstream toe, while discharge through the supply line can also be regulated at a point several hundred feet downstream of Dam No. 1. Neither conduit is valved at its upstream end.

b) Emergency Spillway. The emergency spillway at this facility is a concrete chute approximately 51 feet wide at the control section. It is located along the left side of the main embankment approximately 60 feet from the left abutment. Beyond the control section, the spillway discharge channel is a two-tiered concrete channel less than 50 feet in length. Flow is quickly diverted into a constricted channel approximately 12 feet wide at the base with 3-foot high, hand-placed rock sidewalls. This narrow channel carries discharge downstream where it is released over the left abutment hillside and into the stream below.

c. Design Data and Procedures.

No design data are available for any aspect of this facility.

2.2 Construction Records.

No construction records are available.

2.3 Operating Records.

No operational records are available.

2.4 Other Investigations.

It is our understanding that the owner had retained the services of a consulting engineer to make a detailed hydraulic and hydrologic evaluation of all three Hutchinson facilities. The owner did not provide the inspection team with a copy of the consultant's report.

2.5 Evaluation.

No formal engineering data are available; however, sufficient information in the form of drawings and historical records are available which indicate the facility was constructed around 1903.

It was also learned through observations made during the inspection that both the supply line and blowoff conduit are ungated at their upstream ends. No control is afforded

them should either develop problems upstream of the present gate valve mechanisms. This is considered a deficiency in the design of the outlet system, and requires correction.

## SECTION 3
## VISUAL INSPECTION

### 3.1 Observations.

a. General. Based on the visual inspection, the structure is considered to be in poor condition.

b. Embankment. The embankment presently exists in a deteriorated state characterized by localized slumping and bulging of both slopes, poor alignment in the horizontal and vertical directions, and a general lack of adequate maintenance characterized mainly by overgrown, brush covered slopes.

As indicated in Photograph 4, the main embankment section to the right of the spillway appears arched in the downstream direction. A drawing dated August 1914 (see Figure 3) depicts the embankment as indeed being somewhat parabolic in plan. However, since the drawing was made in 1914 or 11 years after construction, it is likely that it is a representation of existing conditions rather than the original design.

A series of six vertical pipes were observed within the embankment crest during the inspection. Owner's representatives indicated that they were alignment pins installed around 1970; however, no survey data were made available. The presence of the alignment pins suggests that movement of the dam has been a concern of the owner.

The embankment slopes, both upstream and downstream, exhibit an overall decrepitude. The field sketch (Figure 1) shows the approximate area of the upstream slope that appeared to be seriously bulged on the day of the inspection (see Photographs 4 & 6). Field measurements indicate that the upstream slope varies between 2H:1V at the abutments and 1H:1V at the bulged section. The present condition has possibly resulted from excessive drawdown rates. As indicated in Figure 1, the pool level at the time of inspection was at elevation 1320.2, about 15 feet below the spillway crest (reportedly as recently ordered by PennDER).

The downstream slope also exhibits various forms of instability. The most prominent area was observed near the right abutment where a large section of the upper slope, approximately 50 feet in length, has slumped noticeably (see Photograph 3). The downstream slopes are locally steep, generally varying between 2H:1V to 1-1/2H:1V. Much of the slopes are overgrown with weeds, brush, and a few small trees. The rock protection is, for the most part, firmly set (rock slopes were reset by hand in 1970 according to the owner's representative present during the inspection),

although highly irregular (see Photographs 2, and 3). An interesting area is located just above the access road near the center of the embankment. Here an oval shaped excavation was observed in the riprap face. The reason for this depression along with the evidence of grouting associated with it could not be determined (see Photograph 12).

Field measurements indicate areas of differential settlement in excess of one foot located along the crest. In addition, the measured crest width averaged approximately 12 feet across which differs considerably from the 28-foot crest width shown on Figure 3. Generally, the crest exhibits the same lack of uniformity that characterizes the remainder of the embankment. The appearance of the downstream edge of the crest suggests that some sliding and/or erosion has occurred in the past.

c. Appurtenant Structures.

1. Outlet Works. Although the pool level was drawn down during the visual inspection, the inlets to the outlet conduits remained inundated. According to available drawings, the inlets are protected by trash screens (see Figure 3). Both conduits emerge from the embankment and are valved at the downstream toe. The valves appear to be functional, however, they were not operated in the presence of the inspection team (see Photograph 13).

2. Spillway. The visual inspection found the spillway to be in good condition. No significant evidence of concrete deterioration was found in the main channel section which includes the approach section, control section, and downstream tiered section (see Photographs 4 and 9).

The floor of the smaller channel immediately downstream of the main channel section is extensively cracked; however, it appears to be firmly in place. The hand-placed rock sidewalls are well aligned, apparently sturdy, and in good condition (see Photograph 10).

3. West Shore Embankment Extension. The saddle dam extension of the main embankment along the west shore of the reservoir is in generally good condition. It is well constructed and preserved. Field measurements indicate the embankment extension contains areas with differential settlements in excess of one foot (see Photograph 5).

d. Reservoir Area.

The partially drawn down pool level permitted the direct inspection of the reservoir area. Evidence of sedi-

mentation was encountered along the upper reaches of the stream channel within the reservoir area where a moderate volume of fine sandy material several feet thick lined the sides of the channel. Some of this fine material might be the remains of internal piping of the upstream Hutchinson Reservoir Dam No. 3. The remnants of a sediment control screen exist at the upstream reaches of Reservoir No. 2; however, it is no longer functional.

The low pool also revealed several clay plugs within the reservoir area at various locations (see Photographs 5 and 7). No record of this work or the need for it was found in the information available; however, it is assumed that they were placed to curb the seepage repeatedly reported in state inspection reports.

No evidence of slope distress was observed on the surrounding wooded reservoir slopes.

e. Downstream Channel. Hutchinson Reservoir Dams Nos. 1, 2, and 3 were constructed in tandem within the Redstone Creek valley. As shown on the Overview Photograph, Reservoir No. 2 is situated between Reservoirs Nos. 1 and 3 with Reservoir No. 1 located furthest downstream (see Regional Vicinity Map, Appendix G). All three of the structures are located just upstream of the communities of Hutchinson and Hopwood, each having many residences on the Redstone Creek floodplain. The total number of residences which could be affected by a breach of Hutchinson Reservoir No. 2 Dam exceeds 20. Because of the above-mentioned considerations, the facility was given a "high" hazard rating.

## 3.2 Evaluation.

The visual inspection revealed the facility to be in poor condition based primarily on the overall appearance of the main embankment section.

## SECTION 4
## OPERATIONAL PROCEDURES

### 4.1 Normal Operating Procedure.

According to the owner's representatives, there are no formal operating procedures detailed in manual form that pertain to the operation of this facility. Discharge to the supply system is regulated at a distribution box located several hundred feet downstream of Reservoir No. 1. Excess inflow into Reservoir No. 2 passes over the emergency spillway and into the stream channel below that leads to Hutchinson Reservoir No. 1. Emergency drawdown is provided when necessary via the manually operated valve on the discharge end of the blowoff conduit located at the downstream toe of the dam. The valve is operated by the resident dam tender upon the orders of water company officials.

### 4.2 Maintenance of Dam.

There are no formal maintenance procedures at the dam. General maintenance is provided by the resident dam tender on an unscheduled basis.

### 4.3 Maintenance of Operating Facilities.

Other than occasionally operating the gate valves, no regular maintenance is performed on the operating mechanisms.

### 4.4 Warning System.

There are no formal warning systems in effect at this facility. The water company has authored a publication entitled "Emergency Plan to Maintain Safe Potable Water Delivery to Consumers of WPWCO." The plan includes a listing of local radio stations, police, and fire stations, etc. The plan itself makes no provision for a flood emergency warning system but could be easily modified to include one. At present, the resident dam tender is charged with the responsibility of informing the proper authorities in the event of an emergency.

### 4.5 Evaluation.

No formal operation and maintenance manuals are available. There is no formal system in effect to warn downstream residents in the event of an emergency; however, an

existing written emergency plan concerning safe water supply delivery could be modified to include a warning plan.

## SECTION 5
## HYDROLOGIC/HYDRAULIC EVALUATION

### 5.1 Design Data.

No original design data are available. The water company has reportedly retained a consulting engineer to investigate the hydraulic adequacy of the structure. However, details of this investigation were not made available to the inspection team.

### 5.2 Experience Data.

No records of discharge data are available at the facility.

### 5.3 Visual Observations.

On the date of inspection, no conditions were observed that would indicate that the outlet pipes and spillway would not function satisfactorily within the limits of their design during a flood event.

### 5.4 Method of Analysis.

The facility has been analyzed in accordance with the procedures and guidelines established by the U.S. Army Corps of Engineers, Baltimore District, for Phase I hydrologic and hydraulic evaluations. The analysis has been performed utilizing a modified version of the HEC-1 program developed by the U.S. Army Corps of Engineers, Hydrologic Engineering Center, Davis, California.

The Modified HEC-1 Program is capable of performing two basic types of hydrologic analyses: (1) the evaluation of the overtopping potential of the dam and (2) the estimation of the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. The computational procedures typically used in the dam overtopping analysis are as follows:

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.

c. Routing of the inflow hydrograph(s) from the reservoir to desired downstream locations. The results provide estimates of the peak discharge, time of the peak discharge, and the maximum stage of each routed hydrograph at the downstream end of each reach.

The evaluation of the hydrologic-hydraulic consequences resulting from an assumed structural failure (breach) of the dam is typically performed as follows:

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir.

c. Development of a failure hydrograph(s) based on specific breach criteria and normal reservoir outflow.

d. Routing of failure hydrograph(s) to desired downstream locations. The results provide estimates of the peak discharge, time to peak and maximum water surface elevations of failure hydrograph(s) for each location.

## 5.5 Summary of Analysis

### a. Spillway Design Flood (SDF).

In accordance with procedures and guidelines contained in the National Guidelines for Safety Inspection of Dams for Phase I Investigations, the SDF for this facility is the PMF (probable maximum flood). That is, based on the relative size (intermediate) and hazard potential (high) of Hutchinson Reservoir Dam No. 2, the facility is required to have sufficient spillway and storage capacities to safely discharge the PMF without overtopping the embankment.

### b. Results.

Although this report deals specifically with the analysis of Hutchinson Reservoir Dam No. 2., the effects of the upstream Reservoir Dam No. 3. and the downstream Reservoir Dam No. 1 were also considered since they, respectively, control the inflows into, and the downstream damage potential attributable to Reservoir Dam No. 2 (based on present conditons). The dams were investigated such that Reservoir No. 3 was initially empty (as has been the case since 1974), and Reservoirs Nos. 1 and 2 were initially at their normal pool or emergency spillway elevations (although at the time

of inspection, both reservoirs were partially drawn down). The effects of the existing raceways around Reservoirs Nos. 1 and 3 on inflows and outflows were taken into account via the discharge rating curves of the respective dams (Appendix C-1, sheets 10-13 of 13 and sheets 14-15 of 15). Also, the actual estimated storage-elevation relationship of Reservoir No. 2 was modified in order to compensate for the discharge over the left bank of its dam into an adjacent watershed which occurs once the dam is overtopped (Appendix C, sheets 24-29 of 33). All pertinent engineering calculations relative to the analysis of the Hutchinson Dams System are provided in Appendices C and C-1.

Overtopping Analysis (using the Modified HEC-1 Computer Program) of the dams in series indicated that the emergency spillway(s) of each dam could discharge only a small fraction of the PMF prior to overtopping. In particular, Dam No. 3 passed approximately 37 percent of the PMF before overtopping, Dam No. 2 passed about 27 percent of the PMF, and Dam No. 1 passed approximately 33 percent of the PMF (Appendix C, Summary Input/Output Sheets). Analyzed individually, the spillways of Dams Nos. 1 and 2 would be less adequate than stated above, since the effect of an upstream impoundment on a downstream reservoir is to attenuate the potential inflows into, and thus the outflows from the downstream reservoir. Therefore, if Dam No. 3 was ignored in the analysis or removed from the system, the overtopping of Dam No. 2 would occur at a lower percentage of the PMF than reported previously. In either case, Dam No. 2, as well as Dams Nos. 1 and 3, has a high potential for overtopping, and thus for breaching, due to its structural condition (see Section 6 for the structural evaluation of Dam No. 2).

Since none of the three dam facilities of the system could safely pass at least a flood of 1/2 PMF magnitude (the SDF of each of the dams is the full PMF), the possibility of failure of each of the dams under 1/2 PMF conditions was investigated (in accordance with ETL-1110-2-234). It must, however, be understood that it is difficult, if not impossible, to determine exactly how or if a specific dam will fail. Therefore, several possible alternatives were investigated. Again, the dams were evaluated in series so as to ascertain the overall effect of the present system on the downstream population in the event of a severe storm.

The Modified HEC-1 Program was used to generate the possible results of dam breaching due to downcutting by the overtopping waters. Breaching due to piping could not be analyzed directly.

It was assumed, for the purpose of analysis, that breaching would begin once the reservoir water level reached the top of dam elevation of each of the dams. This assumption was based on the opinion that any amount of overtopping can

potentially fail an earth dam, since there are so many unknowns that can contribute to the failure and in the particular case of the Hutchinson Dams, all are of questionable structural integrity (even if the dam is overtopped by only inches). Breaching the dams at their respective top of dam elevations yields minimum downstream consequences due to failure under 1/2 PMF conditions since the volumes of water behind the dams will be at a minimum when failure begins (if one assumes that a dam won't fail unless overtopped). However, in the specific case of the Hutchinson Dams, failure of any of the dams could occur prior to overtopping due to the structural conditions of the dams. That is, failure of each of the dams due to piping under higher than normal heads is a possibility. Dams Nos. 2 and 3 have concrete core walls which may be considered to add to the overall stability of the dams when overtopped. Dam No. 2 is however, visibly misaligned and replete with structural irregularities and a history of seepage problems. All of these deficiencies suggest that the integrity of the present corewall at Dam No. 2 is questionable. Similarly Dam No. 3 is beset by problems the extent of which have caused the owner to maintain the reservoir drained indefinitely until further studies of its present structural integrity can be completed.

An additional overall assumption was that the breach sections would propagate downward to depths equal to the heights of the respective dams (56 feet for Dam No. 3, 47 feet for Dam No. 2, and 33 feet for Dam No. 1), since the impounded streams should tend to seek the previous equilibrium levels which they had attained prior to the construction of the dams (if at all possible).

Two sets of breach section geometry were evaluated for each of two failure times (Appendix C, sheets 30-31 of 33). The two sets of breach sections chosen were considered to be the minimum and maximum probable failure sections. The minimum section for each dam was triangular in shape with very steep side slopes (1/2H to 1V) and a zero bottom width. The maximum section for each dam was trapezoidal in shape with side slopes representative of the estimated side slopes of the valley walls adjacent to the individual dams, and bottom widths equal to the estimated valley widths along the center lines of the individual dams. The two failure times (total time for each breach section to reach its final dimensions) under which the minimum and maximum sections were investigated were assumed to be near instantaneous (15 minutes) and prolonged (4 hours), so that the possible lower and upper limits of this most sensitive variable might be evaluated. The near instantaneous failure time was thought to be realistic if the concrete core walls of Dams Nos. 2 and 3 were indeed in poor condition and/or major piping channels developed prior to and during the early stages of downcutting. The near instantaneous time of failure could also apply if the concrete core walls of Dams

Nos. 2 and 3 were truly in good condition, and could support the respective structures while the downstream toes of the dams were eroded away by the opertopping waters. In such cases, failure by instantaneous overturning of the concrete core walls could occur. The prolonged failure time was thought to be on the optimistic side (with respect to the dams), but still possible at least for Dams Nos. 2 and 3 if their concrete core walls were actually in fair condition, (some cracks). In these cases, the downcutting of the dams would probably be controlled by the slow rates at which the concrete core walls could be broken up and removed, chunk by chunk.

In addition to the above breach conditions, an average or more probable set of conditions was analyzed. These conditions were such that the breach sections were defined by side slopes of 1H to 1V and bottom widths intermediate between the respective minimum and maximum section widths indicated previously. The failure times for Dams Nos. 2 and 3 were assumed to be longer (2 hours) than that for Dam No. 1 (1 hour) due to the possible resistance of their concrete core walls to quick downcutting. The clay puddle core of Dam No. 1 should offer no such resistance.

Regardless of the assumed breach geometry or failure times (and under the "top of dam" initial breaching elevation assumption), the dams always breached in the same sequence. That is, Dam No. 1 failed first, and was followed some time later (about 2 hours) by the failure of Dam No. 2, which was followed a short time later (about 5 minutes) by the failure of Dam No. 3 (Appendix C, Sheet 32 of 33). Further, the same ultimate results were obtained for each set of breaching conditions. Simply stated, the failure of one or more of the dams of the system will significantly increase the estimated non-breach downstream water surface elevations, and thus, the probability of additional loss of life and property damage. A supplementary consequence of the system is that the possible failure of an upstream dam prior to overtopping (for reasons mentioned previously) will most probably cause the failure of a downstream dam.

The near instantaneous failures produced the largest peak outflows and corresponding downstream water surface increases, while the optimistic (with respect to the dam), prolonged failures resulted in much smaller, although still significantly high, relative peak outflows and downstream water surface increases (Appendix C, Sheets 32-33 of 33).

The average or more probable mode of failure provided peak breach discharges of 6000 cfs, 7700 cfs, and 8100 cfs from Dams Nos. 3, 2, and 1, respectively. Downstream water surfaces increased by 5.7 feet (above the maximum 1/2 PMF water surface elevation) at a section located 250 feet downstream of Dam No. 1, and by 4.8 feet (above the same

datum) at a section located about 1500 feet downstream. Even when the system of dams was analyzed such that breaching would not begin until the dams were overtopped by say 0.5 foot of water, the same approximate system results were obtained for the more probable type of failure (Appendix C, Sheets 32 and 33 of 33, Plan 6). The only major difference between the two sets of results was that for the 6-inch failure criterion analysis, all of the dams failed within 15 minutes of each other. In any event, as can be seen on the Regional Vicinity Map (Appendix G), many homes located on the floodplain immediately below the dams would be significantly affected by the dam failures, especially if one considers not only the increase in the height of the breach floodwave, but also the increased momentum that the larger and probably swifter moving volume of water would possess.

Although Reservoir No. 2 is presently only a part of a larger system and was analyzed as such, some approximations can be inferred from the system results as to the downstream effects of the "removal" (by way of estimating and eliminating the increased Dam No. 2 outflows due to upstream breaching) of Dam No. 3. If perhaps Dam No. 3 was "removed" from the system, and Dam No. 1 ignored, the specific outcome of the failure of Dam No. 2 would be to raise the maximum 1/2 PMF water surface elevation (base elevation) at the section located 1,500 feet downstream of Dam No. 1 by about 3 feet, according to the more probable breach analysis. This increase in water surface was determined via the interpolated water surface elevation corresponding to the estimated maximum breach outflow of 3600 cfs. The maximum breach discharge was approximated as the largest difference between the actual computed breach outflows from Dam No. 2 and the estimated Dam No. 3 breach contributions to the Dam No. 2 outflows. Therefore, whether considered alone or, more correctly, as a part of the existing system, the failure of Dam No. 2 is highly possible and will most probably lead to increased loss of life and property damage in the downstream communities.

## 5.6 Spillway Adequacy.

As presented previously, under existing conditions Hutchinson Reservoir Dam No. 2 can safely pass approximately 27 percent of the PMF prior to overtopping. Should a 1/2 PMF-size event occur, the dam will be overtopped and, in all probability, will subsequently fail, endangering the population of the downstream communities. Therefore, the spillway system of Hutchinson Reservoir Dam No. 2 is deemed seriously inadequate.

## SECTION 6
## EVALUATION OF STRUCTURAL INTEGRITY

### 6.1 Visual Observations.

a. Embankment. Based on observations made during the visual inspection, the embankment is considered to be in poor condition. The lack of cross-sectional uniformity and alignment indicate the structure has experienced significant movement over its 75-year history. Although available Pennsylvania State inspection reports document slope instability as early as 1929, subtle movements are likely occurring continually. In fact, in 1970, the owner installed a series of alignment pins across the crest of the embankment, data from which are not available. Nevertheless, their installation suggests recent concern over embankment movements.

With the reservoir drawn down as it was during the inspection, it was not possible to fully assess the effects of seepage associated with the embankment. The low reservoir level did serve to expose several clay plugs upstream of the embankment. The existence of these plugs coupled with the observed seepage at the downstream toe and the history of seepage documented in PennDER files suggests that increased seepage may be observed under normal pool conditions.

b. Appurtenant Structures. The visual inspection revealed the remainder of the facility to be in good condition. The concrete spillway showed no evidence of significant deterioration or damage. The outlet works, although not operated during the inspection, is reported to be functional. This was apparent in that the reservoir had recently been drawn down in accordance with PennDER orders. As noted in Section 2.5, however, the valve mechanisms on the outlet pipes are located downstream of the embankment as opposed to a more desirable upstream location.

### 6.2 Design and Construction Techniques.

No records are available detailing the methods of design and construction.

### 6.3 Past Performance.

No formal records of past performance are available from the owner; however, historical accounts and inspection reports in PennDER files detail a history of seepage and stability problems associated with the facility.

Field inspection revealed obvious embankment deformations, evidence of remedial grouting work on the downstream face, and clay plugs within the embankment, all of which are indicative of poor past performance.

6.4 Seismic Stability.

The dam is located in Seismic Zone No. 1 and is thus subject to minor earthquake induced forces. Since the structure has a history of seepage, it is possible that even minor earthquake induced dynamic forces could be significant at normal operating and high pool levels. However, no investigations or calculations were performed to confirm this opinion.

## SECTION 7
## ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

### 7.1 Dam Assessment.

a. Safety. The visual inspection, operational history, and hydrologic and hydraulic analysis indicate that the structure is in poor condition. Obvious downstream movement of the embankment crest, slump features on both the upstream and downstream slopes, inexplicable probing and grouting on the downstream slope, and evidence of clay plugs within the exposed reservoir surface are indicative of past stability and seepage problems.

Hydrologic and hydraulic calculations indicate that the existing spillway system can pass only 27 percent of the PMF before overtopping of the embankment occurs. Under 1/2 PMF conditions it has been determined that the embankment will be overtopped leading to failure and a potential increase in the hazard to loss of life downstream. As the hazard rating of the facility is high, the present spillway condition is assessed as being seriously inadequate.

The inadequacies of the spillway and apparent instability of the embankment are deficiencies of such a nature that if left uncorrected could result in the failure of the dam with an increase in the potential for loss of life and/or substantial property damage. Thus, the facility is considered unsafe.

The pool level has been lowered by order of PennDER and failure does not appear imminent under the conditions which existed at the time of the field inspection; however, due to the serious inadequacy of the spillway, a detailed emergency operation plan and warning system should be immediately initiated and should include around-the-clock surveillance by a professional engineer experienced in the design and performance evaluation of earth structures during periods of unusually heavy precipitation.

b. Adequacy of Information. The available data are considered sufficient to make a reasonable assessment of the facility. A detailed hydrologic and hydraulic evaluation of all three Hutchinson facilities has reportedly been prepared by a consultant for the owner. This report was not made available for review and could possibly aid in a more accurate assessment of the facilities.

c. Urgency. Detailed evaluation of the facility and implementation of an emergency operation plan, warning system, and around-the-clock surveillance during intense storms should be initiated immediately.

d. Necessity for Additional Investigation. The owner should undertake the following investigations:

1. A subsurface investigation to determine the conditions and engineering properties of the embankment, and underlying materials for use in detailed stability evaluations.

2. Perform a detailed hydrologic and hydraulic evaluation of the facility including an assessment of downstream effects should a decision be made to breach or remove the embankment from the Hutchinson Dam System.

7.2 Recommendations/Remedial Measures.

a. Facilities. It is recommended that the owner:

1. Perform a detailed subsurface evaluation to assess the condition and properties of the embankment and underlying materials.

2. Perform a detailed hydrologic and hydraulic evaluation of the facility including an assessment of downstream effects should a decision be made to breach or remove the embankment from the Hutchinson Dam System.

3. Perform a stability and seepage evaluation of the embankment under all possible operating conditions utilizing the results of item 2, above.

4. Take appropriate remedial actions based on the results of the above analyses.

5. Install valving mechanisms at the upstream ends of both the supply line and blowoff conduit so as to establish flow control at the inlets.

b. Maintenance and Operating Procedures. It is recommended that the owner:

1. Immediately initiate a plan for emergency operation and a warning system for downstream residents. Included in the plan should be provisions for around-the-clock surveillance of the facility by a professional engineer experienced in the design and performance evaluation of earth structures during periods of unusually heavy precipitation.

2. Maintain the drawndown status of the pool level as directed by PennDER until final hydrologic/hydraulic and structural assessments are made of the facility.

3. Formalize a maintenance program that provides for the proper and adequate care of this facility including, but not limited to, the removing of excess brush and overgrowth from the embankment crest and slopes.

# APPENDIX A

## CHECK LIST - ENGINEERING DATA

CHECK LIST
NAME OF DAM: Hutchinson Res. Dam No. 2 ENGINEERING DATA
PHASE I

NDI#: PA-215 PENNDER# : 26-14



| ITEM | REMARKS NDI# PA - 215 |
|---|---|
| PERSONS INTERVIEWED AND TITLE | William McAdams (Engineer) - Western Pennsylvania Water Company<br>John Orlando (Superintendent) - Western Pennsylvania Water Company |
| REGIONAL VICINITY MAP | See Appendix G<br>U.S.G.S. 7.5 minute series quadrangle, Brownfield, Pennsylvania, dated 1964 and photorevised in 1973. |
| CONSTRUCTION HISTORY | Inferred from PennDER correspondence and conversation with the dam owner's representatives. See Section 1.2.f of this report. |
| AVAILABLE DRAWINGS | See Appendix F, Figures 3 and 4. Drawings by W. S. McClay of Uniontown, Pennsylvania, dated August 1914, and July 1915, respectively. |
| TYPICAL DAM SECTIONS | See Appendix F, Figure 2 and 3. |
| OUTLETS:<br>PLAN<br>DETAILS<br>DISCHARGE RATINGS | <br>See Appendix F, Figure 3<br>See Appendix F, Figure 3<br>Not available. |

| ITEM | REMARKS | NDI# PA - 215 |
|---|---|---|
| SPILLWAY:<br>PLAN<br>SECTION<br>DETAILS | See Appendix F, Figures 1, 3 and 4. | |
| OPERATING EQUIPMENT PLANS AND DETAILS | See Appendix F, Figure 3. | |
| DESIGN REPORTS | None. | |
| GEOLOGY REPORTS | None. | |
| DESIGN COMPUTATIONS:<br>HYDROLOGY AND HYDRAULICS<br>STABILITY ANALYSES<br>SEEPAGE ANALYSES | None. | |
| MATERIAL INVESTIGATIONS:<br>BORING RECORDS<br>LABORATORY TESTING<br>FIELD TESTING | None. | |

| ITEM | REMARKS NDI# PA - 215 |
|---|---|
| BORROW SOURCES | Not known. |
| POST CONSTRUCTION DAM SURVEYS | None available. Settlement and alignment pins were installed in 1970 and reportedly surveyed once by representatives of the American Water Works Association. The survey data, however, is not available. |
| POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS | Burgess and Niple of Columbus, Ohio, have been retained by the owner as consultants for Hutchinson Reservoir Dams Nos. 1, 2, and 3. The owner did not provide the inspection team with copies of any pertinent information. |
| HIGH POOL RECORDS | Elevation of highest pool to date is not known. According to the owner's representatives, none of the Hutchinson Dams were ever overtopped. |
| MONITORING SYSTEMS | None. |
| MODIFICATIONS | Original spillway replaced in 1915 with the present structure. No other major modifications have been performed. |

| ITEM | REMARKS NDI# PA |
|---|---|
| PRIOR ACCIDENTS OR FAILURES | The embankment has reportedly never been overtopped. The facility has a history of partial slope failures and seepage; however, incidents resulting in significant property damage or loss of life have never been recorded. |
| MAINTENANCE: RECORDS MANUAL | Maintenance records are not kept for this facility. No formal maintenance manual is available. |
| OPERATION: RECORDS MANUAL | Pool elevation, daily discharge, or operational records are not kept for this facility. No formal operation manual is available. |
| OPERATIONAL PROCEDURES | There are no formal operational procedures associated with this facility. Excess inflow is discharged through the emergency spillway. The outlet works are operated manually by the resident dam tender upon orders from the owner. |
| WARNING SYSTEM AND/OR COMMUNICATION FACILITIES | There are no formal warning systems or emergency procedures presently in effect. A full-time caretaker resides near the facility just downstream of Hutchinson Reservoir Dam No. 2 and is responsible to take whatever steps are necessary to warn downstream residents in the event of an emergency. |
| MISCELLANEOUS | |

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

NDI ID # PA-215
PENN DER ID # 26-14


SIZE OF DRAINAGE AREA: Local ≈ 0.09 sq. miles; Total ≈ 2.0 sq. miles.

ELEVATION TOP NORMAL POOL: 1345.8 STORAGE CAPACITY: 121 acre-feet

ELEVATION TOP FLOOD CONTROL POOL: 1345.8 STORAGE CAPACITY: 121 acre-feet

ELEVATION MAXIMUM DESIGN POOL: Not known STORAGE CAPACITY: Not known

ELEVATION TOP DAM: 1347.6 STORAGE CAPACITY: 136 acre-feet

SPILLWAY DATA

CREST ELEVATION: 1345.8

TYPE: Concrete chute

CHANNEL WIDTH: 50.7 feet (at the control section)

CHANNEL LENGTH: ≈ 200 feet

SPILLOVER LOCATION: Approximately 60 feet right of the left abutment

NUMBER AND TYPE OF GATES: None

OUTLET WORKS

TYPE: 14-inch diameter cast-iron blowoff conduit

LOCATION: Upstream toe to downsteam toe beneath approximate center of embankment.

ENTRANCE INVERTS: elevation 1311 (rough estimate)

EXIT INVERTS: elevation 1304 (rough estimate)

EMERGENCY DRAWDOWN FACILITIES: 14-inch diameter gate value located at downstream toe

HYDROMETEOROLOGICAL GAGES

TYPE: Rain gage

LOCATION: Between Dams Nos. 1 and 2

RECORDS: Daily records available at owner's Uniontown office.

MAXIMUM NON-DAMAGING DISCHARGE: Not known.

# APPENDIX B

## CHECK LIST - VISUAL INSPECTION

CHECK LIST
VISUAL INSPECTION
PHASE 1



NAME OF DAM Hutchinson Res. Dam No. 2 STATE Pennsylvania COUNTY Fayette

NDI# PA - 215 PENNDER# 26-14

TYPE OF DAM Earth SIZE Intermediate HAZARD CATAGORY High

DATE(S) INSPECTION October 6, 1978 WEATHER Overcast TEMPERATURE 50° @ 11:00 AM PM

POOL ELEVATION AT TIME OF INSPECTION 1320.2 M.S.L.

TAILWATER AT TIME OF INSPECTION N/A M.S.L.

| INSPECTION PERSONNEL | OWNER REPRESENTATIVES | OTHERS |
|---|---|---|
| B. M. Mihalcin | W. McAdams | |
| J. P. Nairn | J. Orlando | |
| D. L. Bonk | | |
| S. R. Michalski | | |
| G. R. Thiers | | |
| K. H. Khilji | | |

RECORDED BY B. M. Mihalcin

| ITEM | OBSERVATIONS AND/OR REMARKS NDI# PA - 215 |
|---|---|
| SURFACE CRACKS | Crest overgrown with sassafrass (small), green briar and other low shrubs - except for path across upstream side. Slight cracking evident on upstream side < 1/8-inch wide - no discernable depth - may be from shrinkage or could be effects of drawdown. |
| UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE | None observed. |
| SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES | Slump features evident on both upstream and downstream faces. |
| VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST | Horizontal - obvious downstream bow (estimated 5 to 10 feet).<br>Vertical - Maximum measured settlements in excess of 1 foot (approximately 1.5-foot maximum). |
| RIPRAP FAILURES | See Sheet 3 of 8. |
| JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM | Right abutment - o.k.<br>Spillway to embankment - o.k.<br>Spillway slab - some slumping of riprap.<br>Left abutment - o.k. |

EMBANKMENT

NDI# PA -

| ITEM | OBSERVATIONS AND/OR REMARKS |
|---|---|
| DAMP AREAS IRREGULAR VEGETATION (LUSH OR DEAD PLANTS) | Lush vegetation characterizes practically the entire downstream slope area; however, none of the growth could be positively attributed to excessive dampness along the embankment. |
| ANY NOTICEABLE SEEPAGE | Pool drawn down as per PennDER orders. No evidence of seepage through the embankment slopes was observed. A standing pool of water was noted in the area of the blowoff valve and leakage through the base of the toe was estimated at ≈ 2 gpm. This area has evidenced seepage throughout most of the history of the facility. |
| STAFF GAGE AND RECORDER | Hand-painted markings are located along the upstream riprap face to the right of the spillway and are used to get a visual approximation of the pool level when it is partially or fully drawn down. |
| DRAINS | None observed. |
| | Hand-placed slabby sandstone - very irregular with obvious slump features.<br><br>Hand-placed slabby sandstone - 1) upper level very irregular with obvious slump features - very steep; 2) road level near vertical but alignment good. Rock toe above road level - (a) rounded - hand-placed sandstone; (b) alignment good - slight bulging evident; (c) hole on face ≈ 100 feet from spillway where face removed and grout packed-in; 3) below road level - dumped rounded boulders - graded with 1-1/2 feet maximum. |
| | |

OUTLET WORKS

| ITEM | OBSERVATIONS AND/OR REMARKS NDI# PA - |
|---|---|
| INTAKE STRUCTURE | Submerged. |
| OUTLET CONDUIT (CRACKING AND SPALLING OF CONCRETE SURFACES) | Cast-iron pipes valved at the downstream toe (supply and blowoff lines). Pipes and valves are reportedly functional. |
| OUTLET STRUCTURE | None. |
| OUTLET CHANNEL | Natural streambed partially obstructed by felled tree about 20 feet downstream of the embankment toe. |
| GATE(S) AND OPERATIONAL EQUIPMENT | Blowoff and supply lines are valved at the downstream toe. Both valves were located but neither was operated in the presence of the inspection team. |
| | |

| ITEM | OBSERVATIONS AND/OR REMARKS NDI# PA - 215 |
|---|---|
| TYPE AND CONDITION | Concrete chute spillway in good condition. |
| APPROACH CHANNEL | Near vertical masonry face. Some slumping of the masonry is evident. |
| SPILLWAY CHANNEL AND SIDEWALLS | Concrete surfaces in good condition at spillway control section. Concrete floor of narrow discharge channel is cracked throughout its length but nevertheless appears to be firm. Riprap sidewalls are in good condition. |
| STILLING BASIN PLUNGE POOL | None observed. |
| DISCHARGE CHANNEL | Narrow, concrete channel with hand-placed riprap sidewalls carries flow away from the embankment approximately 150 feet downstream where it is discharged over the left abutment hillside and into the stream below. |
| BRIDGE AND PIERS | A small steel and wood plank bridge spans the narrow spillway discharge channel near the left abutment. |
| EMERGENCY GATES | None observed. |

| ITEM | OBSERVATIONS AND/OR REMARKS NDI# PA -215 |
|---|---|
| TYPE AND CONDITION | N/A |
| APPROACH CHANNEL | N/A |
| OUTLET STRUCTURE | N/A |
| DISCHARGE CHANNEL | N/A |
| | |

| ITEM | OBSERVATIONS AND/OR REMARKS NDI# PA - 215 |
|---|---|
| MONUMENTATION SURVEYS | Six vertical pipes at 75' centers observed along crest. These pipes reportedly are alignment pins placed about 1970 which were read once, but no data pertaining to the alignment pins are available. |
| OBSERVATION WELLS | None. |
| WEIRS | None. |
| PIEZOMETERS | None. |
| OTHERS | None. |

| ITEM | OBSERVATIONS AND/OR REMARKS NDI# PA - 215 |
|---|---|
| SLOPES: RESERVOIR | Steep and heavily wooded. |
| SEDIMENTATION | The drawn down pool encountered on the day of the inspection afforded the inspection team a partial view of the reservoir bottom. Some evidence of sedimentation was observed particularly toward the inlet end of the reservoir. It was estimated that several feet of fines have been deposited in this area and there is likely to be much more at the base of the upstream toe. |
| DOWNSTREAM CHANNEL (OBSTRUCTIONS, DEBRIS, ETC.) | Natural stream with rock bottom - small pond is located just upstream of the inlet to Reservoir No. 1. |
| SLOPES: CHANNEL VALLEY | Valley side slopes are steep and heavily wooded. The valley floor is gently sloping between Reservoirs 2 and 1 and only moderately wooded in that a large portion of the right side of the valley has been cleared to accommodate the caretaker's residence. |
| APPROXIMATE NUMBER OF HOMES AND POPULATION | The caretaker's residence is located between Dams Nos. 2 and 1. Portions of the communities of Hutchinson and Hopwood are located along the flood-plain just downstream of the reservoirs. At least 20 homes could easily be affected by a breach of Hutchinson Reservoir Dam No. 1. Population - 60-80. |
| | |

# APPENDIX C

# HYDROLOGY AND HYDRAULICS

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 2

BY DLB DATE 10-27-78 PROJ. NO. 78-617-215

CHKD. BY WJV DATE 1/9/79 SHEET NO. 1 OF 33

gai CONSULTANTS.
Engineers • Geologists • Planners
Environmental Specialists

DAM LOCATION - BROWNFIELD QUADRANGLE, FAYETTE COUNTY, PENNSYLVANIA; U.S.G.S. 7.5 MINUTE SERIES, (TOPOGRAPHIC) PHOTOREVISED 1973

## DAM STATISTICS

MAXIMUM HEIGHT - 47 FEET (FIELD MEASURED)

DRAINAGE AREA - 2.0 SQ. MI. (PLANIMETERED OFF U.S.G.S. BROWNFIELD QUADRANGLE)

STORAGE CAPACITY -

@ NORMAL POOL (EL 1345.8) - 121 AC-FT (SEE NOTE BELOW)
@ TOP OF DAM (EL 1347.6) - 136 AC-FT (SHEET 5)

## SIZE CLASSIFICATION

DAM SIZE - INTERMEDIATE (REF 1; TABLE 1)

HAZARD RATING - HIGH (FIELD OBSERVATION; REF 1; TABLE 2

REQUIRED SDF - PMF (REF 1; TABLE 3)

NOTE: THE VALUE OF STORAGE CAPACITY IS TAKEN FROM AN UNPUBLISHED NOTEBOOK CONTAINING PERTINANT DATA FOR DAMS OPERATED BY THE UNIONTOWN BRANCH OF W.P.W.. THE NOTEBOOK IS AVAILABLE FROM THE FILES LOCATED AT UNIONTOWN OFFICE OF W.P.W

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR # 2
BY KHK DATE 10-12-78 PROJ. NO. 78-617-215
CHKD. BY RFV DATE 10-17-78 SHEET NO. 2 OF 33

gai CONSULTANTS, INC
Engineers • Geologists • Planners
Environmental Specialists

# HUTCHINSON RESERVOIR # 2.

## DRAINAGE AREA:

LOCAL = 0.09 SQ. MILE (PLANIMETERED).

OVERALL TOTAL = 1.9 + .09 = 1.99 SQ. MILES
≈ 2.0 SQ. MILES.

## SURFACE AREA (NORMAL POOL) ELEV 1345.8 ≈ 1346

= .087 SQ. IN. (PLANIMETERED).

= 7.99 ACRES USE 8 ACRES.

SURFACE AREA AT CONTOUR 1360 = 0.143 SQ. IN. (PLANIMETERED)
= 13.13 ACRES. USE 13.1

RATE OF AREA CHANGE PER FOOT OF RISE:

$$\frac{\Delta A}{\Delta y} = \frac{(13.1 \text{ ACRES}) - (8.0 \text{ ACRES})}{(1360 \text{ FEET}) - (1346 \text{ FEET})} = 0.36 \text{ ACRE/FT}$$

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR # 2

BY KHK DATE 10-24-78 PROJ. NO. 78-617-215

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## UNIT HYDROGRAPH PARAMETERS.

LENGTH OF LONGEST WATERCOURSE (L) ≃ 0.51 MILES

$L_{CA}$ ≃ 0.17 MILES

[VALUES OF L AND $L_{CA}$ ARE FROM U.S.G.S. 7.5 MINUTE SERIES QUAD BROWNFIELD, PA.]

NOTE: ALL VARIABLES ARE DEFINED IN REFERENCE 2 IN THE SECTION ENTITLED "SNYDER SYNTHETIC UNIT HYDROGRAPH".

$C_t = 1.6$

$C_p = 0.5$

[SUPPLIED BY C OF E; ZONE 29, OHIO RIVER BASIN]

$t_p$ = SNYDER'S STANDARD LAG = $1.6(L \times L_{CA})^{0.3}$

$t_p = (1.6)[(0.51)(0.17)]^{0.3} = 0.77$ HRS

## PMP CALCULATIONS

HUTCHINSON DAM # 2 LOCATION ZONE 7 (REF 3)

PMP INDEX = 24 INCHES (FIGURE 1, REF 3)

DURATION % INDEX :-

6 HRS = 102

12 HRS = 120

24 HRS = 130

NOTE: A 24-HOUR DURATION RATHER THAN A 48-HOUR DURATION WAS USED. THIS WAS NECESSITATED BY THE NEED TO USE A 5-MINUTE TIME STEP IN THE HEC-I-DAM PROGRAM IN ORDER TO MORE ACCURATELY DEFINE THE PEAKS OF THE HYDROGRAPHS. (A MAXIMUM OF ONLY 300 TIME INTERVALS IS ALLOWED IN THE PROGRAM.)

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR # 2
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## APPROXIMATE ELEVATION @ ZERO STORAGE

VOLUME = $\frac{1}{3}$ HA (CONIC METHOD)

NORMAL POOL VOLUME = 121 AC-FT (WPW. FILES UNION TOWN OFFICE)

AREA = 8.0 ACRES (PLANIMETERED)

$$H = \frac{3 \times 121}{8} = 45.4 \text{ FT} \approx 45.4 \text{ FT}$$

HEIGHT OF DAM = 47 FT (FIELD MEASURED)

USE 47.

ELEVATION OF ZERO VOLUME = 1346 - 47
= 1299 FT

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR NO 2

BY WJV DATE 1/4/79 PROJ. NO. 78-617-215

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## ACTUAL ESTIMATED ELEVATION - STORAGE RELATIONSHIP

ESTIMATED SURFACE AREA : $A = A_0 + \left(\frac{\Delta A}{\Delta Y}\right) Y$
(LINEAR INTERPOLATION EQUATION)

$A_0 = 8.0$ ACRES

$\frac{\Delta A}{\Delta Y} = 0.36$ ACRES/FOOT

$Y = (\text{ELEVATION OF CONCERN}) - 1345.9'$

ESTIMATED INCREMENTAL INCREASE IN STORAGE :

MODIFIED PRISMOIDAL FORMULA : $\Delta V_{1-2} = \frac{Y}{3}\left(A_1 + A_2 + \sqrt{A_1 \cdot A_2}\right)$
(REF 14, PG 15)

| | ELEVATION (FT) | ESTIMATED AREA (ACRE) | CUMULATIVE INCREASE IN STORAGE ABOVE NORMAL POOL VIA MOD. PRIS. EQ (A-F) | AVAILABLE STOR BELOW NORMAL POOL (A-F) | ACTUAL ESTIMATED STORAGE (A-F) | |
|---|---|---|---|---|---|---|
| NORMAL POOL — | 1345.9 | 8.0 | 0 | 121 | 121 | KNOWN VALUE |
| | 1346.0 | 8.1 | 2 | " | 123 | |
| | 1347.0 | 8.4 | 10 | " | 131 | |
| TOP OF DAM — | 1347.6 | 8.6 | 15 | " | 136 | |
| | 1348.0 | 8.8 | 19 | " | 140 | |
| | 1349.0 | 9.2 | 28 | " | 149 | |
| | 1350.0 | 9.5 | 37 | " | 153 | |
| | 1351.0 | 9.9 | 47 | " | 168 | |
| | 1352.0 | 10.2 | 57 | " | 178 | |
| | 1353.0 | 10.6 | 67 | " | 188 | |
| | 1354.0 | 11.0 | 78 | " | 199 | |
| | 1355.0 | 11.3 | 89 | " | 210 | |
| | 1356.0 | 11.7 | 100 | " | 221 | |

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 2

BY WJV DATE 1/4/79 PROJ. NO. 78-617-215

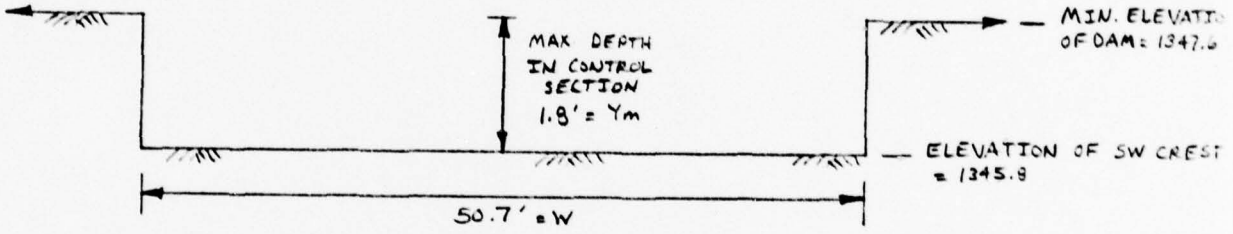
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# EMERGENCY SPILLWAY CAPACITY

## RECTANGULAR SPILLWAY SECTION WITH CRITICAL FLOW CONTROL

CONTROL SECTION : (NOT TO SCALE)




NOTE: SPILLWAY ELEVATION OBTAINED FROM FIGURE 3, APPENDIX F. ALL OTHER MEASUREMENTS OBTAINED IN FIELD

SUPERCRITICAL FLOW IS ASSUMED BELOW THE SPILLWAY CREST WITH THE WATER SURFACE PROFILE PASSING THROUGH CRITICAL DEPTH AT THE CONTROL SECTION.

ENERGY BALANCE BETWEEN RESERVOIR AND CONTROL SECTION:

$$Y_m + \frac{v_R^2}{2g}^{0} = Y_c + \frac{v_c^2}{2g} + H_L^{0}$$

(REF 12)

$$\therefore\ Y_m = 1.8' = Y_c + \frac{v_c^2}{2g}$$

WHERE: $v_R$ = RESERVOIR APPROACH VELOCITY (ASSUMED NEGLIGIBLE)

$Y_c$ = CRITICAL CONTROL SECT. DEPTH

$v_c$ = CRITICAL CONTROL SECT. VELOCITY

$H_L$ = HEAD LOSS BETWEEN THE RESERVOIR ENTRANCE TO THE SPILLWAY AND THE CONTROL SECT. (ASSUMED NEGLIGIBLE)

SUBJECT DAM SAFETY INSPECTION
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THE CRITICAL VELOCITY IN A RECTANGULAR SECTION IS GIVEN BY : $V_c = \sqrt{g y_c}$ (REF 13, PG 141)

FUTHERMORE FOR A RECTANGULAR CHANNEL :

SPECIFIC ENERGY = $Y_m = 1.5 y_c$ (REF 13, PG 143)

$1.8 FT = 1.5 y_c$

$y_c = 1.2 FT$

∴ THE CRITICAL VELOCITY IS:

$V_c^2 = y_c(g)$

$V_c = \sqrt{y_c g}$

$V_c = \sqrt{(1.2)g}$

$V_c = 6.22$ ft/sec

THE FLOW CAN BE CALCULATED : $Q_c = V_c A_c$

THE AREA IS: $W(y_c) = 50.7'(1.2) = 60.84 FT^2 = A_c$

$Q_c$ = MAXIMUM SPILLWAY CAPACITY

$Q_c = (6.22)(60.84) \simeq 378$ CFS (SAY 380 CFS)

SUBJECT DAM SAFETY INSPECTION
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THE CRITICAL SLOPE CAN BE FOUND BY USE OF THE MANNING FORMULA: $S_c = \left(\frac{n Q}{1.49 A_c R_c^{2/3}}\right)^2$ (REF 13, pg 143)

where $n$ = MANNINGS Roughness coefficient (0.014 FOR CONCRETE) (REF 13, pg 133)

$R_c$ = HYDRAULIC RADIUS = $\frac{\text{AREA OF FLOW}}{\text{WETTED PERIMETER}}$

FOR THIS CASE $R_c = \frac{(50.7)(1.2)}{50.7 + 2(1.2)} = \underline{\underline{1.15}}$

$\therefore S_c = \left(\frac{0.014(378)}{1.49(60.84)(1.15)^{2/3}}\right)^2 = 0.0028$

$0.0028 < 0.03$ where 0.03 is THE SLOPE OF THE CHUTE CHANNEL BELOW THE SPILLWAY

$\therefore$ CRITICAL FLOW CONTROLS THE SPILLWAY DISCHARGE

SUBJECT DAM SAFETY INSPECTION
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# SPILLWAY RATING CURVE

$y_c$ = HEAD/1.5 ; $V_c = (g)(y_c)^{1/2}$ ; $A_c = 50.7\, y_c$ ; $Q = A_c V_c$

| HEAD (FT) | ELEVATION (FT) | $y_c$ | $V_c$ | $A_c$ | $Q$ |
|---|---|---|---|---|---|
| 0 | 1345.8 | 0 | 0 | 0 | 0 |
| 0.2 | 1346.0 | 0.13 | 2.05 | 6.59 | 13.5 |
| 1.2 | 1347.0 | 0.80 | 5.08 | 40.56 | 206.0 |
| 1.8 | 1347.6 | 1.20 | 6.22 | 60.84 | 378.4 |
| 2.2 | 1348.0 | 1.47 | 6.88 | 74.53 | 512.8 |
| 3.2 | 1349.0 | 2.13 | 8.28 | 107.99 | 894.2 |
| 4.2 | 1350.0 | 2.80 | 9.50 | 141.96 | 1,348.6 |
| 5.2 | 1351.0 | 3.47 | 10.57 | 175.93 | 1,859.6 |
| 6.2 | 1352.0 | 4.13 | 11.53 | 209.39 | 2,414.3 |
| 7.2 | 1353.0 | 4.80 | 12.43 | 243.36 | 3,025.0 |
| 8.2 | 1354.0 | 5.47 | 13.27 | 277.33 | 3,680.2 |
| 9.2 | 1355.0 | 6.13 | 14.05 | 310.79 | 4,366.6 |
| 10.2 | 1356.0 | 6.80 | 14.80 | 344.76 | 5,102.4 |

SUBJECT DAM SAFETY INSPECTION
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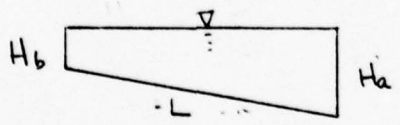
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# MAIN DAM RATING CURVE

THE MAIN DAM IS DIVIDED INTO FIVE SEGMENTS DUE TO SLIGHT CHANGES IN THE HEIGHT OF THE DAM ALONG ITS LENGTH SECTION 1 IS FROM STATION 0+00 TO 0+60; SECTION 2 FROM STA 1+10 TO 1+60; SECTION 3 FROM STA 1+60 TO 4+60; SECTION 4 FROM STA 4+60 TO 5+10; AND SECTION 5 FROM STA 5+10 TO 5+66. FOR OVERTOPPING, TAKE AVERAGE HEIGHT ON THE OVERTOPPED PORTION OF EACH SECTION. OVERTOPPING OCCURS WHEN WATER SURFACE ELEVATION IS 1347.6

FOR ALL SECTIONS $Q_i = \frac{2}{5} \frac{C_i L_i}{H_a - H_b} \left( H_a^{5/2} - H_b^{5/2} \right)$

(Derived form of $Q = C_L H^{3/2}$; REF. 14 - Chapter A-5 p. 3)




$C_i$ can be determined from $H_i = \frac{\frac{H_a + H_b}{2}}{\ell}$

IF $H_b = 0$ then $Q_i = \frac{2}{5} C L H_a^{3/2}$ where $C = f\left(\frac{H_a}{2\ell}\right)$

IF $H_a = H_b$ use original formula $Q_i = C_i L_i H_i^{3/2}$

NOTE: Assume the embankment will discharge as a broad crested weir during overtopping with a breadth of 12 ft.

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR #2

BY RFV DATE 10-18-78 PROJ. NO. 78-617-215

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SECTION 1 of MAIN DAM (STATIONS 0+00 to 0+60) L=60'

| ELEVATION | $H_A$ (FT) | $H_B$ (FT) | $\frac{H_a+H_B}{2}$ | C | L (FT) | $Q_1 = \frac{2}{5} \frac{C L}{H_a - H_b} (H_a^{5/2} - H_b^{5/2})$ |
|---|---|---|---|---|---|---|
| 1348.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1348.8 | 0.1 | 0 | 0.004 | 2.90 | 60 | 5.5 |
| 1349.0 | 0.3 | 0.2 | 0.021 | 2.97 | | 22.5 |
| 1349.2 | 0.5 | 0.4 | 0.038 | 3.01 | | 54.6 |
| 1349.4 | 0.7 | 0.6 | 0.054 | 3.02 | | 95.0 |
| 1349.6 | 0.9 | 0.8 | 0.071 | 3.03 | | 142.5 |
| 1349.8 | 1.1 | 1.0 | 0.088 | 3.03 | | 195.7 |
| 1350.0 | 1.3 | 1.2 | 0.104 | 3.04 | | 255.0 |
| 1350.5 | 1.8 | 1.7 | 0.146 | 3.05 | | 423.7 |
| 1351.0 | 2.3 | 2.2 | 0.188 | 3.07 | | 621.7 |
| 1351.5 | 2.8 | 2.7 | 0.229 | 3.08 | | 842.8 |
| 1352.0 | 3.3 | 3.2 | 0.271 | 3.09 | | 1086.3 |
| 1353.0 | 4.3 | 4.2 | 0.354 | 3.09 | | 1624.4 |
| 1354.0 | 5.3 | 5.2 | 0.438 | 3.09 | | 2230.3 |
| 1355.0 | 6.3 | 6.2 | 0.521 | 3.09 | | 2896.9 |
| 1356.0 | 7.3 | 7.2 | 0.604 | 3.09 | | 3619.3 |

SUBJECT DAM SAFETY INSPECTION
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SECTION 2 of MAIN DAM (STATIONS 1+10 to 1+60) L=50'

| ELEVATION | $H_A$ (FT) | $H_B$ (FT) | $\frac{H_A+H_B}{2}$ | C | L (FT) | $Q_2 = \frac{2}{5} \frac{CL}{H_a - H_b}\left(H_a^{5/2} - H_b^{5/2}\right)$ |
|---|---|---|---|---|---|---|
| 1347.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1347.8 | 0.2 | 0 | 0.008 | 2.94 | 7.1 | 0.7 |
| 1348.0 | 0.4 | 0 | 0.017 | 2.96 | 14.3 | 4 |
| 1348.2 | 0.6 | 0 | 0.025 | 2.98 | 21.4 | 12 |
| 1348.4 | 0.8 | 0 | 0.033 | 3.00 | 28.6 | 25 |
| 1348.6 | 1.0 | 0 | 0.042 | 3.01 | 35.7 | 43 |
| 1348.8 | 1.2 | 0 | 0.050 | 3.02 | 42.9 | 68 |
| 1349.0 | 1.4 | 0 | 0.058 | 3.02 | 50 | 100 |
| 1349.2 | 1.6 | 0.2 | 0.075 | 3.03 | ↓ | 139 |
| 1349.4 | 1.8 | 0.4 | 0.092 | 3.04 | | 184 |
| 1349.6 | 2.0 | 0.6 | 0.108 | 3.04 | | 234 |
| 1349.8 | 2.2 | 0.8 | 0.125 | 3.04 | | 287 |
| 1350.0 | 2.4 | 1.0 | 0.142 | 3.05 | | 345 |
| 1350.5 | 2.9 | 1.5 | 0.183 | 3.08 | | 509 |
| 1351.0 | 3.4 | 2.0 | 0.225 | 3.08 | | 689 |
| 1351.5 | 3.9 | 2.5 | 0.267 | 3.09 | | 890 |
| 1352.0 | 4.4 | 3.0 | 0.308 | 3.09 | | 1105 |
| 1353.0 | 5.4 | 4.0 | 0.392 | 3.09 | | 1579 |
| 1354.0 | 6.4 | 5.0 | 0.475 | 3.09 | | 2107 |
| 1355.0 | 7.4 | 6.0 | 0.558 | 3.09 | | 2683 |
| 1356.0 | 8.4 | 7.0 | 0.642 | 3.09 | | 3305 |

SUBJECT DAM SAFETY INSPECTION
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SECTION 3 OF MAIN DAM (STATIONS 1+60 to 4+60)
L = 300 FT

| ELEVATION | $H_A$(FT) | $H_B$(FT) | $\frac{H_A+H_B}{2}$ | C | L(FT) | $Q_3 = \frac{2}{5}\frac{CL}{H_a-H_b}\left(H_a^{5/2} - H_b^{5/2}\right)$ |
|---|---|---|---|---|---|---|
| 1347.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1347.8 | 0.1 | 0 | 0.004 | 2.90 | 23.1 | 1 |
| 1348.0 | 0.3 | 0 | 0.013 | 2.94 | 69.2 | 13. |
| 1348.2 | 0.5 | 0 | 0.021 | 2.96 | 115.4 | 48. |
| 1348.4 | 0.7 | 0 | 0.029 | 2.99 | 161.5 | 113. |
| 1348.6 | 0.9 | 0 | 0.038 | 3.01 | 207.7 | 214 |
| 1348.8 | 1.1 | 0 | 0.046 | 3.02 | 253.8 | 354 |
| 1349.0 | 1.3 | 0 | 0.054 | 3.02 | 300.0 | 537. |
| 1349.2 | 1.5 | 0.2 | 0.071 | 3.03 | | 766 |
| 1349.4 | 1.7 | 0.4 | 0.088 | 3.03 | | 1026 |
| 1349.6 | 1.9 | 0.6 | 0.104 | 3.04 | | 1318. |
| 1349.8 | 2.1 | 0.8 | 0.121 | 3.04 | | 1633 |
| 1350.0 | 2.3 | 1.0 | 0.138 | 3.04 | | 1971 |
| 1350.5 | 2.8 | 1.5 | 0.179 | 3.06 | | 2927. |
| 1351.0 | 3.3 | 2.0 | 0.221 | 3.08 | | 4016. |
| 1351.5 | 3.8 | 2.5 | 0.263 | 3.09 | | 5210 |
| 1352.0 | 4.3 | 3.0 | 0.304 | 3.09 | | 6490 |
| 1353.0 | 5.3 | 4.0 | 0.388 | 3.09 | | 9318 |
| 1354.0 | 6.3 | 5.0 | 0.471 | 3.09 | | 12,470 |
| 1355.0 | 7.3 | 6.0 | 0.554 | 3.09 | | 15,916 |
| 1356.0 | 8.3 | 7.0 | 0.638 | 3.09 | | 19,632. |

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SECTION 4 OF MAIN DAM (STATIONS 4+60 TO 5+10)
L = 50'

| ELEVATION | $H_A$ (FT) | $H_B$ (FT) | $\frac{H_A+H_B}{2}$ | C | L (FT) | $Q_4 = \frac{2}{5}\frac{CL}{H_a-H_b}\left(H_a^{5/2} - H_b^{5/2}\right)$ |
|---|---|---|---|---|---|---|
| 1347.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1347.8 | 0.1 | 0 | 0.004 | 2.90 | 3.6 | .0 |
| 1348.0 | 0.3 | 0 | 0.013 | 2.94 | 10.7 | 2 |
| 1348.2 | 0.5 | 0 | 0.021 | 2.96 | 17.9 | 8 |
| 1348.4 | 0.7 | 0 | 0.029 | 2.99 | 25.0 | 18 |
| 1348.6 | 0.9 | 0 | 0.038 | 3.01 | 32.1 | 33. |
| 1348.8 | 1.1 | 0 | 0.046 | 3.02 | 39.3 | 55 |
| 1349.0 | 1.3 | 0 | 0.054 | 3.02 | 46.4 | 83. |
| 1349.2 | 1.5 | 0.1 | 0.067 | 3.03 | 50.0 | 119. |
| 1349.4 | 1.7 | 0.3 | 0.083 | 3.03 | | 161. |
| 1349.6 | 1.9 | 0.5 | 0.100 | 3.04 | | 208. |
| 1349.8 | 2.1 | 0.7 | 0.117 | 3.04 | | 260 |
| 1350.0 | 2.3 | 0.9 | 0.133 | 3.04 | | 315. |
| 1350.5 | 2.8 | 1.4 | 0.175 | 3.06 | | 472. |
| 1351.0 | 3.3 | 1.9 | 0.217 | 3.08 | | 652 |
| 1351.5 | 3.8 | 2.4 | 0.258 | 3.09 | | 849 |
| 1352.0 | 4.3 | 2.9 | 0.300 | 3.09 | | 1,060 |
| 1353.0 | 5.3 | 3.9 | 0.383 | 3.09 | | 1,529 |
| 1354.0 | 6.3 | 4.9 | 0.467 | 3.09 | | 2,051 |
| 1355.0 | 7.3 | 5.9 | 0.550 | 3.09 | | 2,623 |
| 1356.0 | 8.3 | 6.9 | 0.633 | 3.09 | | 3,241 |

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SECTIONS OF MAIN DAM (STATIONS 5+10 to 5+60)
L = 50'

| ELEVATION | H (FT) | H/L | C | L (FT) | $Q_S = CLH^{3/2}$ |
|---|---|---|---|---|---|
| 1349.1 | 0 | 0 | 0 | 0 | 0 |
| 1349.2 | 0.1 | 0.008 | 2.94 | 50 | 5 |
| 1349.4 | 0.3 | 0.025 | 2.98 | | 25 |
| 1349.6 | 0.5 | 0.042 | 3.01 | | 53. |
| 1349.8 | 0.7 | 0.058 | 3.02 | | 88. |
| 1350.0 | 0.9 | 0.075 | 3.03 | | 129 |
| 1350.5 | 1.4 | 0.117 | 3.04 | | 252 |
| 1351.0 | 1.9 | 0.158 | 3.05 | | 399. |
| 1351.5 | 2.4 | 0.200 | 3.07 | | 571 |
| 1352.0 | 2.9 | 0.242 | 3.08 | | 761 |
| 1353.0 | 3.9 | 0.325 | 3.09 | | 1,190 |
| 1354.0 | 4.9 | 0.408 | 3.09 | | 1,676 |
| 1355.0 | 5.9 | 0.492 | 3.09 | | 2,214. |
| 1356.0 | 6.9 | 0.575 | 3.09 | | 2,800. |

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR #2

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# TOTAL RATING CURVE FOR MAIN DAM

| ELEVATION | $Q_1$ | $Q_2$ | $Q_3$ | $Q_4$ | $Q_5$ | $Q_T = \sum_{i=1}^{5} Q_i$ (CFS) |
|---|---|---|---|---|---|---|
| 1347.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1347.8 | 0 | 0.7 | 0.8 | 0.1 | 0 | 2 |
| 1348.0 | 0 | 4.3 | 13.4 | 2.1 | 0 | 20 |
| 1348.2 | 0 | 11.9 | 48.3 | 7.5 | 0 | 68 |
| 1348.4 | 0 | 24.6 | 113.1 | 17.5 | 0 | 155. |
| 1348.6 | 0 | 43.0 | 213.5 | 33.0 | 0 | 290 |
| 1348.8 | 5.5 | 68.1 | 353.7 | 54.8 | 0 | 482. |
| 1349.0 | 22.5 | 100.1 | 537.2 | 83.1 | 0 | 743. |
| 1349.2 | 54.6 | 139.4 | 765.7 | 119.1 | 4.6 | 1,083 |
| 1349.4 | 95.0 | 184.4 | 1,025.6 | 161.0 | 24.5 | 1,491 |
| 1349.6 | 142.5 | 233.6 | 1,318.1 | 208.4 | 53.2 | 1,956 |
| 1349.8 | 195.7 | 286.9 | 1,632.7 | 259.7 | 88.4 | 2,463. |
| 1350.0 | 255.0 | 345.2 | 1,970.7 | 315.0 | 129.4 | 3,015. |
| 1350.5 | 423.7 | 508.9 | 2,927.2 | 472.1 | 251.8 | 4,584 |
| 1351.0 | 621.7 | 689.0 | 4,016.1 | 651.5 | 399.4 | 6,378 |
| 1351.5 | 842.8 | 889.7 | 5,210.2 | 848.7 | 570.7 | 8,362. |
| 1352.0 | 1,086.3 | 1,104.5 | 6489.9 | 1,060.3 | 760.5 | 10,502 |
| 1353.0 | 1,624.4 | 1,578.5 | 9,317.9 | 1,528.7 | 1,189.9 | 15,239. |
| 1354.0 | 2230.3 | 2,106.5 | 12,470.1 | 2,051.4 | 1,675.8 | 20,534. |
| 1355.0 | 2,896.9 | 2683.1 | 15,915.9 | 2,623.3 | 2,214.1 | 26,333. |
| 1356.0 | 3,619.3 | 3,304.6 | 19,632.0 | 3,240.5 | 2,800,3 | 32,597 |

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR #2

BY RFV DATE 10-18-78 PROJ. NO. 78-617-215

CHKD. BY KWH DATE 10-24-78 SHEET NO. 17 OF 33

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## SPILLWAY AND MAIN DAM RATING CURVE

| ELEVATION | SPILLWAY $Q_S$ | MAIN DAM $Q_M$ | COMBINED FLOW $Q_T$ (CFS) |
|---|---|---|---|
| 1345.8 | 0 | 0 | 0 |
| 1346.0 | 14 | 0 | 14 |
| 1347.0 | 206 | 0 | 206. |
| 1347.6 | 378 | 0 | 378. |
| 1348.0 | 513 | 20 | 533 |
| 1349.0 | 894 | 743 | 1,637 |
| 1350.0 | 1,349 | 3,015 | 4,364 |
| 1351.0 | 1860 | 6,378 | 8,238 |
| 1352.0 | 2,414 | 10,502 | 12,916 |
| 1353.0 | 3,025 | 15,239 | 18,264 |
| 1354.0 | 3680 | 20,534 | 24,214. |
| 1355.0 | 4,367 | 26,333 | 30,700 |
| 1356.0 | 5,102 | 32,597 | 37,699. |

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 2

BY RFV DATE 10/20/79 PROJ. NO. 79-617-215

CHKD. BY WJV DATE 1/2/79 SHEET NO. 18 OF 33

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## FLOW OVER LEFT BANK OF DAM

DUE TO THE LOCATION OF DAM #2 AND A LOW SPOT IN THE SURROUNDIN TERRAIN, A PORTION OF THE TOTAL RESERVOIR DISCHARGE WILL FLOW OVER THE LEFT BANK AND INTO AN ADJACENT WATERSHED IF THE RESERVOIR ELEVATION EXCEEDS 1347.7 FEET (SEE REGIONAL VACINITY MAP, APPENDIX G)

IN ORDER TO ACCOUNT FOR THIS ADDITIONAL OUTLET, A RATING TABLE WAS COMPUTED. THE LEFT BANK WAS DIVIDED INTO THREE SECTIONS FOR CALCULATION OF FLOW. SECTION 1 IS FROM STA 0+00 to STA 2+10 (SEE SKETCH MAP, APPEN. F). SECTION 2 IS FROM STA 2+10 TO 2+60. SECTION 3 IS FROM STA 2+60 TO 3+60. THE BREADTH OF THE ASSUMED BROAD CRESTED WEIR-LIKE LEFT BANK WAS TAKEN TO BE 50 FEET.

THE SAME PROCEDURE USED IN COMPUTING THE FLOWS OVER THE MAIN DAM WAS USED TO COMPUTE THE LEFT BANK FLOWS.

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR #2

BY RFV DATE 10-18-78 PROJ. NO. 78-617-215

CHKD. BY KHH DATE 10-24-78 SHEET NO. 19 OF 33

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LEFT BANK : SECTION 1 (STATION 0+00 TO 2+10)

L = 210'

| ELEVATION (FT) | $H_A$ (FT) | $H_B$ (FT) | $\frac{H_A+H_B}{2}$ | C* | L (FT) | $Q_1 = \frac{2}{5} \frac{CL}{H_A-H_B} \left(H_A^{5/2} - H_B^{5/2}\right)$ |
|---|---|---|---|---|---|---|
| 1347.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1347.8 | 0.1 | 0 | 0.001 | 2.90 | 23.3 | 0.9 |
| 1348.0 | 0.3 | 0 | 0.003 | 2.94 | 70.0 | 13.5 |
| 1348.2 | 0.5 | 0 | 0.005 | 2.96 | 116.7 | 48.9 |
| 1348.4 | 0.7 | 0 | 0.007 | 2.99 | 163.3 | 115.1 |
| 1348.6 | 0.9 | 0 | 0.009 | 3.01 | 210.0 | 215.9 |
| 1348.8 | 1.1 | 0.2 | 0.013 | 3.02 | | 352.7 |
| 1349.0 | 1.3 | 0.4 | 0.017 | 3.03 | | 516.3 |
| 1349.2 | 1.5 | 0.6 | 0.021 | 3.03 | | 700.4 |
| 1349.4 | 1.7 | 0.8 | 0.025 | 3.04 | | 906.7 |
| 1349.6 | 1.9 | 1.0 | 0.029 | 3.04 | | 1,128.1 |
| 1349.8 | 2.1 | 1.2 | 0.033 | 3.04 | | 1,365.7 |
| 1350.0 | 2.3 | 1.4 | 0.037 | 3.04 | | 1,618.3 |
| 1350.5 | 2.8 | 1.9 | 0.047 | 3.05 | | 2,318.0 |
| 1351.0 | 3.3 | 2.4 | 0.057 | 3.05 | | 3,089.2 |
| 1351.5 | 3.8 | 2.9 | 0.067 | 3.05 | | 3,886.7 |
| 1352.0 | 4.3 | 3.4 | 0.077 | 3.05 | | 4,846.7 |
| 1353.0 | 5.3 | 4.4 | 0.097 | 3.05 | | 6,843.6 |
| 1354.0 | 6.3 | 5.4 | 0.117 | 3.05 | | 9069.3 |
| 1355.0 | 7.3 | 6.4 | 0.137 | 3.05 | | 11,489.2 |
| 1356.0 | 8.3 | 7.4 | 0.157 | 3.05 | | 14,093.0 |

* VALUES OF "C" OBTAINED FROM REF. 12, PG 46

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR #2

BY REV DATE 10-18-78 PROJ. NO. 78-617-215

CHKD. BY KWH DATE 10-24-78 SHEET NO. 20 OF 33

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LEFT BANK : SECTION 2 (STATION 2+10 to 2+60) L = 50'

| ELEVATION (FT) | $H_A$ (FT) | $H_B$ (FT) | $\frac{H_A+H_B}{2}$ | C* | L (FT) | $Q_2 = \frac{2}{3} \frac{CL}{H_A H_B} \left(H_A^{5/2} - H_B^{5/2}\right)$ |
|---|---|---|---|---|---|---|
| 1347.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1347.8 | 0.1 | 0 | 0.001 | 2.90 | 5.6 | 0.2 |
| 1348.0 | 0.3 | 0 | 0.003 | 2.94 | 16.7 | 3.2 |
| 1348.2 | 0.5 | 0 | 0.005 | 2.96 | 27.8 | 11.6 |
| 1348.4 | 0.7 | 0 | 0.007 | 2.99 | 38.9 | 27.4 |
| 1348.6 | 0.9 | 0 | 0.009 | 3.01 | 50.0 | 51.4 |
| 1348.8 | 1.1 | 0.2 | 0.013 | 3.02 | ↓ | 84.0 |
| 1349.0 | 1.3 | 0.4 | 0.017 | 3.03 | ↓ | 122.9 |
| 1349.2 | 1.5 | 0.6 | 0.021 | 3.03 | ↓ | 166.8 |
| 1349.4 | 1.7 | 0.8 | 0.025 | 3.04 | ↓ | 215.9 |
| 1349.6 | 1.9 | 1.0 | 0.029 | 3.04 | ↓ | 268.6 |
| 1349.8 | 2.1 | 1.2 | 0.033 | 3.04 | ↓ | 325.2 |
| 1350.0 | 2.3 | 1.4 | 0.037 | 3.04 | ↓ | 385.3 |
| 1350.5 | 2.8 | 1.9 | 0.047 | 3.05 | ↓ | 551.9 |
| 1351.0 | 3.3 | 2.4 | 0.057 | 3.05 | ↓ | 736.1 |
| 1351.5 | 3.8 | 2.9 | 0.067 | 3.05 | ↓ | 937.2 |
| 1352.0 | 4.3 | 3.4 | 0.077 | 3.05 | ↓ | 1,154.0 |
| 1353.0 | 5.3 | 4.4 | 0.097 | 3.05 | ↓ | 1,630.6 |
| 1354.0 | 6.3 | 5.4 | 0.117 | 3.05 | ↓ | 2,159.4 |
| 1355.0 | 7.3 | 6.4 | 0.137 | 3.05 | ↓ | 2,735.5 |
| 1356.0 | 8.3 | 7.4 | 0.157 | 3.05 | ↓ | 3,355.5 |

* VALUES OF "C" OBTAINED FROM REF 12, pg 46

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR #2

BY RFV DATE 10-18-78 PROJ. NO. 78-617-215

CHKD. BY KWW DATE 10-24-78 SHEET NO. 21 OF 33

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LEFT BANK : SECTION 3 (STATION 2+60 to 3+60)
L = 100'

| ELEVATION (FT) | $H_A$ (FT) | $H_B$ (FT) | $\frac{H_A+H_B}{2}$ | C* | L (FT) | $Q_3 = \frac{2}{5}\frac{CL}{H_A-H_B}(H_A^{5/2}-H_B^{5/2})$ |
|---|---|---|---|---|---|---|
| 1348.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1348.8 | 0.2 | 0 | 0.002 | 2.94 | 50 | 5.3 |
| 1349.0 | 0.4 | 0 | 0.004 | 2.96 | 100 | 30.0 |
| 1349.2 | 0.6 | 0.2 | 0.008 | 3.00 | | 78.3 |
| 1349.4 | 0.8 | 0.4 | 0.012 | 3.02 | | 142.3 |
| 1349.6 | 1.0 | 0.6 | 0.016 | 3.03 | | 218.5 |
| 1349.8 | 1.2 | 0.8 | 0.020 | 3.03 | | 304.5 |
| 1350.0 | 1.4 | 1.0 | 0.024 | 3.04 | | 401.0 |
| 1350.5 | 1.9 | 1.5 | 0.034 | 3.04 | | 675.0 |
| 1351.0 | 2.4 | 2.0 | 0.044 | 3.05 | | 996.3 |
| 1351.5 | 2.9 | 2.5 | 0.054 | 3.05 | | 1,354.1 |
| 1352.0 | 3.4 | 3.0 | 0.064 | 3.05 | | 1,746.8 |
| 1353.0 | 4.4 | 4.0 | 0.084 | 3.05 | | 2,626.1 |
| 1354.0 | 5.4 | 5.0 | 0.104 | 3.05 | | 3,617.3 |
| 1355.0 | 6.4 | 6.0 | 0.124 | 3.05 | | 4,709.1 |
| 1356.0 | 7.4 | 7.0 | 0.144 | 3.05 | | 5,893.0 |

* VALUES OF "C" OBTAINED FROM REF 12, pg 46

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR #2

BY RFV DATE 10-18-78 PROJ. NO. 78-617-215

CHKD. BY KWK DATE 10-24-78 SHEET NO. 22 OF 33

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## TOTAL LEFT BANK RATING CURVE

| ELEVATION (FT) | $Q_1$ | $Q_2$ | $Q_3$ | $Q_T$ |
|---|---|---|---|---|
| 1347.7 | 0 | 0 | 0 | 0 |
| 1347.8 | 0.9 | 0.2 | 0 | 1 |
| 1348.0 | 13.5 | 3.2 | 0 | 17 |
| 1348.2 | 48.9 | 11.6 | 0 | 61 |
| 1348.4 | 115.1 | 27.4 | 0 | 143 |
| 1348.6 | 215.9 | 51.4 | 0 | 267 |
| 1348.8 | 352.7 | 84.0 | 5.3 | 442 |
| 1349.0 | 516.3 | 122.9 | 30.0 | 669 |
| 1349.2 | 700.4 | 166.8 | 78.3 | 946 |
| 1349.4 | 906.7 | 215.9 | 142.3 | 1265 |
| 1349.6 | 1,128.1 | 268.6 | 218.5 | 1615 |
| 1349.8 | 1,365.7 | 325.2 | 304.5 | 1995 |
| 1350.0 | 1618.3 | 385.3 | 401.0 | 2405 |
| 1350.5 | 2,318.0 | 551.9 | 675.0 | 3545 |
| 1351.0 | 3,089.2 | 736.1 | 996.3 | 4822 |
| 1351.5 | 3,886.7 | 937.2 | 1,354.1 | 6178 |
| 1352.0 | 4846.7 | 1,154.0 | 1,746.8 | 7748 |
| 1353.0 | 6,843.6 | 1,630.6 | 2,626.1 | 11,100 |
| 1354.0 | 9,069.3 | 2,159.4 | 3,617.3 | 14,846 |
| 1355.0 | 11,489.2 | 2,735.5 | 4709.1 | 18,934 |
| 1356.0 | 14,093.0 | 3,355.5 | 5,893.0 | 23,342 |

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR #2

BY RFV DATE 10-24-78 PROJ. NO. 78-617-215

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## TOTAL DAM RATING CURVE (SPILLWAY + MAIN DAM + LEFT BANK)

| ELEVATION | MAIN DAM + SPILLWAY Q | LEFT BANK Q | TOTAL Q CFS |
|---|---|---|---|
| 1345.8 | 0 | 0 | 0 |
| 1346 | 14 | 0 | 14 |
| 1347 | 206 | 0 | 206 |
| 1347.6 | 378 | 0 | 378 |
| 1348 | 533 | 17 | 550 |
| 1349 | 1,637 | 669 | 2,306 |
| 1350 | 4,364 | 2,405 | 6,769 |
| 1351 | 8,237 | 4,822 | 13,059 |
| 1352 | 12,916 | 7,748 | 20,664 |
| 1353 | 18,264 | 11,100 | 29,364 |
| 1354 | 24,214 | 14,846 | 39,060 |
| 1355 | 30,700 | 18,934 | 49,634 |
| 1356 | 37,699 | 23,342 | 61,041 |

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 2

BY WJV DATE 1/2/79 PROJ. NO. 78-617-215

CHKD. BY DLB DATE 1/9/79 SHEET NO. 24 OF 33

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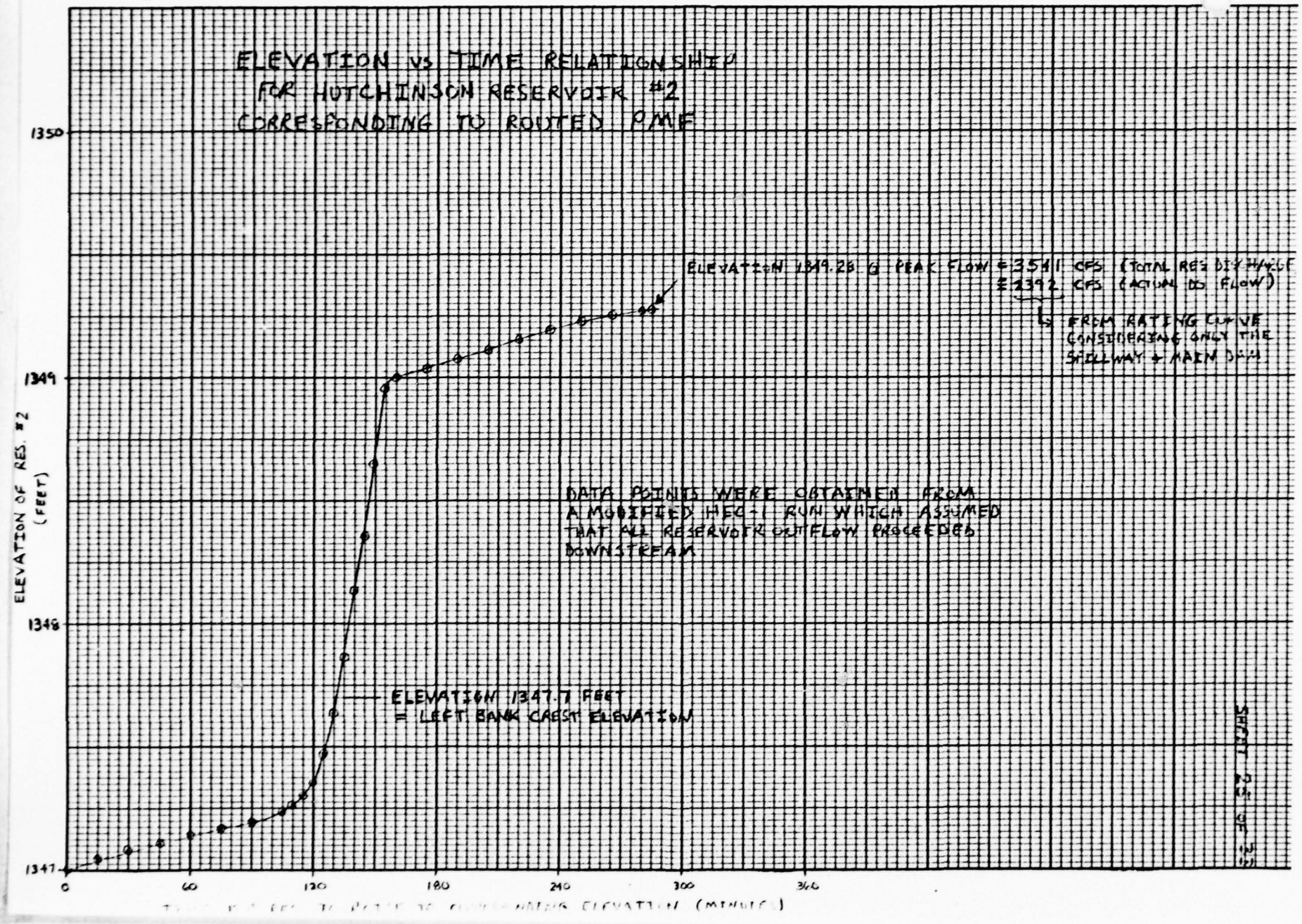
## LEFT BANK DISCHARGE PROBLEM

THE MODIFIED HEC-I PROGRAM ASSUMES THAT ALL RESERVOIR OUTFLOW PROCEEDS DIRECTLY DOWNSTREAM. HOWEVER, ABOVE ELEVATION 1347.7 A PORTION OF THE TOTAL RESERVOIR #2 OUTFLOW (ABOUT 1/3 OF THE PEAK PMF FLOW) DISCHARGES OVER THE LEFT BANK OF THE DAM AND INTO AN ADJACENT WATERSHED.

SINCE THE PROGRAM CANNOT DIRECTLY SEPERATE THE LEFT BANK DISCHARGES FROM THE TOTAL RESERVOIR DISCHARGES, A SCHEME TO CONVERT THE LEFT BANK FLOW VALUES TO STORAGE VALUES WAS DEVELOPED. (MODIFIED PULS ROUTING IS BASICALLY A PROCEDURE WHICH BALANCES INFLOWS AND OUTFLOWS WITH AVAILABLE STORAGE. THEREFORE, IF THE INFLOW HYDROGRAPH IS HELD CONSTANT, THE RESERVOIR OUTFLOWS ARE DIRECTLY CONTROLLED BY THE STORAGE ⇒ TO DECREASE OR ELIMINATE A PORTION OF THE DISCHARGE, THE CORRESPONDING STORAGE MUST BE INCREASED TO COMPENSATE.)

AN INITIAL COMPUTER RUN WAS MADE ASSUMING THAT ALL RESERVOIR OUTFLOW PROCEEDED DOWNSTREAM (i.e, A RATING TABLE CONSIDERING TOTAL DISCHARGE FROM THE SPILLWAY, THE MAIN DAM, AND THE LEFT BANK WAS USED; SHEET 23 ), SO THAT THE ACTUAL RESERVOIR SURFACE FLUCTUATIONS (ELEVATION vs TIME RELATIONSHIP) RESULTIN FROM ROUTING THE PMF COULD BE ESTABLISHED.

THE RESERVOIR ELEVATION vs TIME INFORMATION (SHEET 25 IN CONJUNCTION WITH THE LEFT BANK RATING TABLE (SHEET 2 ENABLED INITIAL ESTIMATES OF THE VOLUMES OF WATER


ELEVATION VS TIME RELATIONSHIP
FOR HUTCHINSON RESERVOIR #2
CORRESPONDING TO ROUTED PMF
ELEVATION 1349.26 @ PEAK FLOW = 3541 CFS (TOTAL RES DISCHARGE
= 2392 CFS (ACTUAL OUTFLOW)
FROM RATING CURVE
CONSIDERING ONLY THE
SPILLWAY & MAIN DAM
DATA POINTS WERE OBTAINED FROM
A MODIFIED HEC-1 RUN WHICH ASSUMED
THAT ALL RESERVOIR OUTFLOW PROCEEDED
DOWNSTREAM
ELEVATION 1347.7 FEET
= LEFT BANK CREST ELEVATION
ELEVATION OF RES. #2
(FEET)
1350
1349
1348
1347
0
60
120
180
240
300
360
SHEET NO. OF

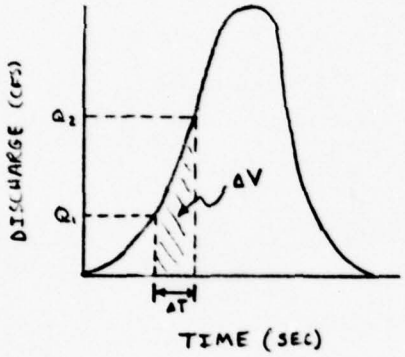
SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 2

BY WJV DATE 1/3/79 PROJ. NO. 78-617-215

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DISCHARGING OVER THE LEFT BANK TO BE COMPUTED. THESE VOLUMES WERE CALCULATED ACCORDING TO THE LOGICAL RELATIONSHIP BELOW, WHICH STATES THAT THE VOLUME OF WATER PASSED DURING A CERTAIN TIME PERIOD IS EQUAL TO THE AVERAGE DISCHARGE MULTIPLIED BY THE TOTAL TIME LENGTH OF THAT PERIOD (SEE SKETCH):




$$\Delta V = \left[ \left( \frac{Q_1 + Q_2}{2} \right) \times \Delta T \right] / 43560 \text{ FT}^3/\text{ACRE}$$

WHERE $\Delta V$ = INCREMENTAL VOLUME OF WATER DISCHARGED OVER THE LEFT BANK (A-F),

$Q_1$ = FLOW OVER THE LEFT BANK CORRESPONDING TO ELEVATION 1 (CFS)

$Q_2$ = FLOW OVER THE LEFT BANK CORRESPONDING TO ELEVATION 2 (CFS)

$\Delta T$ = TIME NECESSARY FOR RESERVOIR TO RAISE FROM ELEVATION 1 TO ELEVATION 2 (SEC).

THE VOLUMES OF WATER COMPUTED WITH THE ABOVE EQUATION WERE ADDED TO THE ACTUAL ESTIMATED AVAILABLE STORAGE VALUES AT THE APPROPRIATE ELEVATIONS (SHEET 27). A COMPUTER RUN WAS MADE USING THESE INITIAL ARTIFICIAL STORAGE VALUES (ACTUAL + INITIAL VALUES ON SHEET 27) TO REPLACE THE LEFT BANK DISCHARGE POTENTIAL, AND USING THE SPILLWAY + MAIN DAM RATING TABLE (SHEET 17) TO DETERMINE THE RESERVOIR OUTFLOWS.

THE OUTPUT FROM THE ABOVE RUN SHOWED THAT FURTHER CALIBRATION OF THE ARTIFICIAL STORAGE VALUES WAS NECESSARY. THEREFORE, BY TRIAL AND ERROR THE FINAL

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 2

BY WJV DATE 1/4/79 PROJ. NO. 78-617-215

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## REVISED ELEVATION - STORAGE RELATIONSHIP

| ELEVATION (FT) | ACTUAL ESTIMATED STORAGE * (A-F) | CUMULATIVE INITIAL ARTIFICIAL STORAGE VALUES (A-F) | ACTUAL + INITIAL STORAGE VALUES (A-F) | FINAL ARTIFICIAL STORAGE VALUES (A-F) |
|---|---|---|---|---|
| 1299.0 | 0 | 0 | 0 | 0 |
| 1345.8 | 121 | 0 | 121 | 121 |
| 1346.0 | 123 | 0 | 123 | 123 |
| 1347.0 | 131 | 0 | 131 | 131 |
| 1347.6 | 136 | 0 | 136 | 136 |
| 1347.7 | 137 | 0 | 137 | 137 |
| 1347.8 | 138 | 0 | 138 | 138 |
| 1348.0 | 140 | 0.1 | 140.1 | 140.1 |
| 1348.2 | 141.8 ** | 0.4 | 142.2 | 142.2 |
| 1348.4 | 143.6 ** | 0.9 | 144.5 | 144.5 |
| 1348.6 | 145.4 ** | 1.9 | 147.3 | 147.3 |
| 1348.8 | 147.2 ** | 3.7 | 150.9 | 150.9 |
| 1349.0 | 149 | 9.9 | 158.9 | 158.9 |
| 1349.2 | 150.8 ** | 98.8 | 249.6 | 300.0 |
| 1349.3 | 151.7 ** | 183.6 | 335.3 | 500.0 |

* VALUES FROM SHEET 5

** INTERPOLATED VALUE

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 2

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ARTIFICIAL STORAGE VALUES ON SHEET 27 WERE ARRIVED AT. (THE PURPOSE OF THE FURTHER CALIBRATION WAS TO BETTER REPRODUCE THE KNOWN PMF DOWNSTREAM OUTFLOW HYDROGRAPH WHICH WAS OBTAINED BY APPLYING THE SPILLWAY + MAIN DAM RATING TABLE TO THE RESERVOIR ELEVATION INFORMATION ON SHEET 25).

THE ABOVE APPROACH TO THE LEFT BANK DISCHARGE PROBLEM WAS CHOSEN INSTEAD OF JUST SIMPLY MULTIPLYING THE TOTAL RESERVOIR OUTFLOW HYDROGRAPH ORDINATES BY A RATIO (ie, 0.67) TO OBTAIN MORE REALISTIC DOWNSTREAM FLOWS, SINCE THE RATIO METHOD WOULD LEAD TO MORE ERRONEOUS RESULTS, ESPECIALLY DURING BREACHING ANALYSIS. THAT IS, ONCE A BREACH OCCURS, THE WATER BEHIND THE DAM QUICKLY RECEDES BELOW THE LEFT BANK CREST ELEVATION, AND ALL OUTFLOW THEREAFTER IS DIRECTED DOWNSTREAM. HOWEVER, IF THE RATIO METHOD WAS USED ALL OF THE BREACH OUTFLOWS, WHETHER ACTUALLY AFFECTED BY THE LEFT BANK OR NOT, WOULD FIRST BE MULTIPLIED BY THE RATIO BEFORE INFLOW INTO RESERVOIR Nº 1 OR FURTHUR DOWNSTREAM TRAVEL. THIS THEN WOULD LEAD TO VERY CONSERVATIVE RESULTS DOWNSTREAM. IN ADDITION, THE OUTFLOW HYDROGRAPHS GENERATED DURING OVERTOPPING ANALYSIS (ESPECIALLY FOR THE LOWER FRACTIONS OF THE PMF) WOULD BE QUITE CONSERVATIVE VOLUME-WISE, BECAUSE ALL ORDINATES WOULD BE MULTIPLIED BY THE ONE RATIO VALUE, WHEREAS THE RATIO ACTUALLY VARIES WITH THE RESERVOIR ELEVATION.

THE ARTIFICIAL STORAGE APPROACH ALSO HAS SOME MINOR DRAWBACKS IN THAT THE RECESSION LIMBS OF THE OUTFLOW HYDROGRAPHS GENERATED DURING OVERTOPPING ANALYSIS ARE

| | | | | | |
|---|---|---|---|---|---|
| 1356.0 | 6.9 | 0.575 | 3.09 | ↓ | 2,800. |

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 2

BY WJV DATE 1/3/79 PROJ. NO. 78-617-215

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INCORRECT SINCE THEY CONTAIN THE EFFECTS OF THE ARTIFICIAL STORAGE VOLUMES BEING DISCHARGED DOWNSTREAM (THE FLOW VALUES ARE LARGER THAN SHOULD BE). HOWEVER, THE RECESSION LIMB OF THE HYDROGRAPH IS OF LITTLE IMPORTANCE IN THIS ANALYSIS. THE EFFECT OF THE ARTIFICIAL STORAGE ON THE BREACHING ANALYSIS IS TO CAUSE A SLIGHTLY LARGER VOLUME OF WATER TO BE DISCHARGED DOWNSTREAM ONCE THE BREACH OCCURS. HOWEVER, BREACHING IS ASSUMED TO BEGIN AT ELEVATION 1348.6 (1 FOOT ABOVE THE DAM), AND AT THIS ELEVATION THE ADDITIONAL VOLUME DISCHARGED DOWNSTREAM IS NEGLIGIBLE (1.8 A-F, SHEET 27).

THEREFORE, THE ARTIFICIAL STORAGE APPROACH TO THE LEFT BANK PROBLEM IS THOUGHT TO GIVE MORE ACCURATE RESULTS DOWNSTREAM OF RESERVOIR Nº 2 FOR THIS PHASE I ANALYSIS

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 2

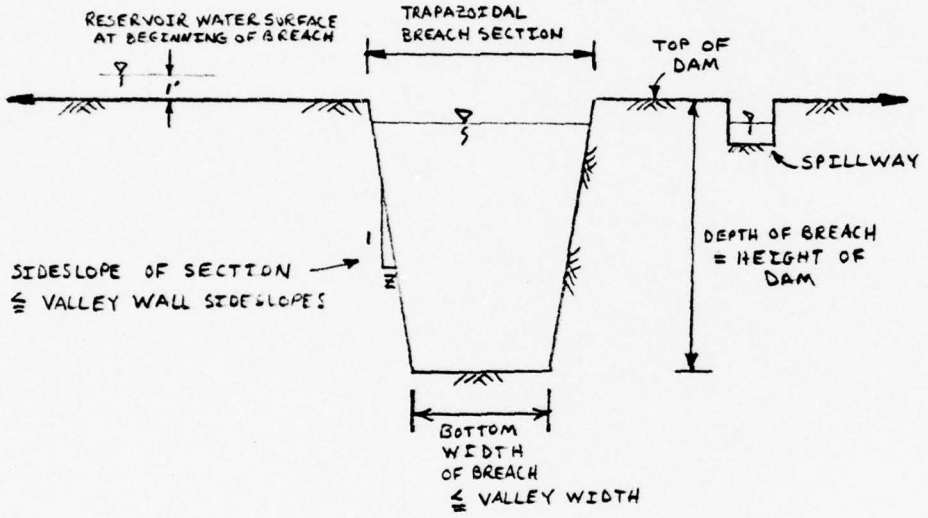
BY WJV DATE 2-2-79 PROJ. NO. 78-617-215

CHKD. BY DLB DATE 2-6-79 SHEET NO. 30 OF 33

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# BREACHING ASSUMPTIONS

## TYPICAL BREACH SECTION:




## HEC-1-DAM BREACHING ANALYSIS INPUTS:

(BREACHING IS INITIATED WHEN THE RESERVOIR WATER SURFACES REACH THE TOPS OF THE DAMS)

| PLAN NUMBER AND COMMENTS | RESERVOIR Nº 3 | | | | RESERVOIR Nº 2 | | | | RESERVOIR Nº 1 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BREACH BOTTOM WIDTH (FT) | BREACH DEPTH (FT) | SECTION SIDESLOPE | BREACH* TIME (HR) | BREACH BOTTOM WIDTH (FT) | BREACH DEPTH (FT) | SECTION SIDESLOPE | BREACH* TIME (HR) | BREACH BOTTOM WIDTH (FT) | BREACH DEPTH (FT) | SECTION SIDESLOPE | BREACH* TIME (HR) |
| ① MINIMUM BREACH SECTIONS, INSTANTANEOUS FAIL TIMES | 0 | 56 | 0.5 to 1 | 0.25 | 0 | 47 | 0.5 to 1 | 0.25 | 0 | 33 | 0.5 to 1 | 0.25 |
| ② MAXIMUM BREACH SECTIONS, INSTANTANEOUS FAIL TIMES | 150 | 56 | 2 to 1 | 0.25 | 100 | 47 | 4 to 1 | 0.25 | 100 | 33 | 2.5 to 1 | 0.25 |
| ③ MINIMUM BREACH SECTIONS, PROLONGED FAIL TIMES | 0 | 56 | 0.5 to 1 | 4.0 | 0 | 47 | 0.5 to 1 | 4.0 | 0 | 33 | 0.5 to 1 | 4.0 |
| ④ MAXIMUM BREACH SECTIONS, PROLONGED FAIL TIMES | 150 | 56 | 2 to 1 | 4.0 | 100 | 47 | 4 to 1 | 4.0 | 100 | 33 | 2.5 to 1 | 4.0 |
| ⑤ AVERAGE POSSIBLE CONDITIONS | 100 | 56 | 1 to 1 | 2.0 | 50 | 47 | 1 to 1 | 2.0 | 50 | 33 | 1 to 1 | 1.0 |

* BREACH TIME = TOTAL TIME NECESSARY TO REACH THE FINAL BREACH DIMENSIONS

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº2

BY WJV DATE 1/9/79 PROJ. NO. 78-617-215

CHKD. BY DLB DATE 1/9/79 SHEET NO. 31 OF 33

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ASSUMPTIONS ARE BASED SOMEWHAT ON THE FOLLOWING SUGGESTED RANGES FOR EARTH DAM BREACHING*:

- BREACH BOTTOM WIDTH → $\frac{\text{DAM HEIGHT}}{2}$ < WIDTH < 3 × (DAM HEIGHT)
- SECTION SIDESLOPE → $0 < Z < 1$
- BREACH TIME → $0.5 < \text{TIME} < 4.0$
- WATER SURFACE HEIGHT ABOVE DAM AT WHICH BREACHING BEGINS → $1 < \text{HEIGHT} < 5$

AND ALSO ON THE PHYSICAL CONSTRAINTS OF THE DAM AND SURROUNDING TERRAIN:

| CONSTRAINT | RESERVOIR Nº3 | RESERVOIR Nº2 | RESERVOIR Nº1 |
|---|---|---|---|
| - HEIGHT OF DAM | 56' | 47' | 33' |
| - LENGTH OF DAM CREST W/O SW | 400' | 510' (MAIN DAM ONLY) | 278' |
| ** - VALLEY BOTTOM WIDTH | 150' | 100' | 100' |
| ** - VALLEY SS: RIGHT WALL | 3 to 1 | 4 to 1 | 3.5 to 1 |
| LEFT WALL | 4.5 to 1 | 5 to 1 | 4 to 1 |
| DESCRIPTION | EARTH DAM WITH CONCRETE CORE WALL AND CONCRETE US FACE COVERING | EARTH DAM WITH CONCRETE CORE WALL AND HAND PLACED RIP RAP US AND DS FACE COVERINGS | EARTH DAM WITH CLAY CORE AND CONCRETE US FACE COVERING |

* INFORMATION OBTAINED FROM BALTIMORE DISTRICT, CORPS OF ENGINEERS

SUBJECT DAM SAFETY INSPECTION

HUTCHINSON RESERVOIR Nº 2

BY WJV DATE 2-2-79 PROJ. NO. 78-617-215

CHKD. BY DLB DATE 2-6-79 SHEET NO. 32 OF 33

# HEC-1-DAM BREACHING ANALYSIS OUTPUT:

## RESERVOIR DATA

| OUTPUT FOR RESERVOIR Nº | PLAN * NUMBER | VARIABLE BOTTOM BREACH WIDTH RES. 3 | RES. 2 | RES. 1 | ACTUAL MAX. FLOW DURING FAIL TIME (CFS) | CORRESPONDING TIME OF FLOW (HR) | INTERPOLATED OR HEC-1 ROUTED MAX FLOW DURING FAIL TIME (CFS) | CORRESPONDING TIME OF FLOW (HR) | ACTUAL PEAK FLOW THROUGH DAM (CFS) | CORRESPONDING TIME OF PEAK (HR) | TIME OF INITIAL BREACH (HR) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | ① | 0 | – | – | 19572 | 18.50 | 19572 | 18.50 | 19572 | 18.50 | 18.25 |
| | ② | 150 | – | – | 29691 | 18.37 | 26618 | 18.33 | 29691 | 18.37 | 18.25 |
| | ③ | 0 | – | – | 3138 | 20.42 | 3138 | 20.42 | 3138 | 20.42 | 18.25 |
| | ④ | 150 | – | – | 4330 | 18.75 | 4330 | 18.75 | 4330 | 18.75 | 18.25 |
| | ⑤ | 100 | – | – | 5997 | 18.63 | 5982 | 18.58 | 5997 | 18.63 | 18.25 |
| | ** ⑥ | 100 | – | – | 5996 | 18.93 | 5996 | 18.93 | 5996 | 18.93 | 18.50 |
| 2 | ① | 0 | 0 | – | 12319 | 18.42 | 12319 | 18.42 | 15532 | 18.58 | 18.17 |
| | ② | 150 | 100 | – | 32481 | 18.37 | 32303 | 18.42 | 32481 | 18.37 | 18.17 |
| | ③ | 0 | 0 | – | 3762 | 20.42 | 3762 | 20.42 | 3762 | 20.42 | 18.17 |
| | ④ | 150 | 100 | – | 5255 | 18.75 | 5255 | 18.75 | 5255 | 18.75 | 18.17 |
| | ⑤ | 100 | 50 | – | 7734 | 18.75 | 7734 | 18.75 | 7734 | 18.75 | 18.17 |
| | ** ⑥ | 100 | 50 | – | 7597 | 18.92 | 7597 | 18.92 | 7597 | 18.92 | 18.33 |
| 1 | ① | 0 | 0 | 0 | 2947 | 16.14 | 2771 | 16.50 | 15715 | 18.58 | 16.25 |
| | ② | 150 | 100 | 100 | 4636 | 16.31 | 3015 | 16.33 | 33969 | 18.42 | 16.25 |
| | ③ | 0 | 0 | 0 | – | – | – | – | 3927 | 20.50 | 16.25 |
| | ④ | 150 | 100 | 100 | 5748 | 18.75 | 5748 | 18.75 | 5748 | 18.75 | 16.25 |
| | ⑤ | 100 | 50 | 50 | 1738 | 16.48 | 1628 | 16.42 | 8115 | 18.75 | 16.25 |
| | ** ⑥ | 100 | 50 | 50 | 8479 | 18.90 | 8385 | 18.92 | 8479 | 18.90 | 18.42 |

* SEE TABLE ON SHEET 30;

** { AVERAGE POSSIBLE CONDITIONS - BASED ON ASSUMPTION OF ½ FT OF OVERTOPPING PRIOR TO BREACHING

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SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR NO 2
BY WJV DATE 2-2-79 PROJ. NO. 79-617-215
CHKD. BY DLB DATE 2-6-79 SHEET NO. 33 OF 33

# HEC-1- DAM BREACHING ANALYSIS OUTPUT :

## DOWNSTREAM ROUTING DATA

| LAN No. [1] | VARIABLE BREACH BOTTOM WIDTH RES.3 | RES.2 | RES.1 | OUTPUT @ X-SECT LOCATED 250 FT DS OF DAM NO 1 PEAK FLOW (CFS) | TIME OF FLOW (HR) | CORR WSEL (FT) | WSEL [2] W/O BREACH (FT) | ΔELEV [3] (FT) | OUTPUT @ X-SECT LOCATED 1500 FT DS OF DAM NO 1 PEAK FLOW (CFS) | TIME OF FLOW (HR) | CORR WSEL (FT) | WSEL [2] W/O BREACH (FT) | ΔELEV [3] (FT) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ① | 0 | 0 | 0 | 15983 | 18.58 | 1266.0 | 1256.6 | 9.4 | 16206 | 19.58 | 1220.9 | 1211.7 | 9.2 |
| ② | 150 | 100 | 100 | 34669 | 18.42 | 1271.6 | 1256.6 | 15.0 | 34624 | 18.42 | 1225.6 | 1211.7 | 13.9 |
| ③ | 0 | 0 | 0 | 3936 | 20.50 | 1259.4 | 1256.6 | 2.8 | 3930 | 20.50 | 1214.7 | 1211.7 | 3.0 |
| ④ | 150 | 100 | 100 | 5750 | 18.83 | 1260.8 | 1256.6 | 4.2 | 5762 | 18.83 | 1216.0 | 1211.7 | 4.3 |
| ⑤ | 100 | 50 | 50 | 8112 | 18.75 | 1262.3 | 1256.6 | 5.7 | 8040 | 18.75 | 1217.5 | 1211.7 | 5.8 |
| ⑥ [4] | 100 | 50 | 50 | 8415 | 18.92 | 1262.5 | 1256.6 | 5.9 | 8325 | 18.92 | 1217.7 | 1211.7 | 6.0 |

1. SEE TABLE ON SHEET 30
2. BASE FLOW ELEVATIONS CORRESPONDING TO THE PEAK ½ PMF FLOW. ESTIMATED FROM THE OVERTOPPING ANALYSIS OUTPUT (SEE SUMMARY INPUT/OUTPUT SHEETS)
3. ΔELEV = (CORRESPONDING WSEL) - (WSEL W/O BREACH)
4. BASED ON ASSUMPTION OF ½ FT OF OVERTOPPING PRIOR TO BREACHING (AVERAGE POSSIBLE CONDITIONS)

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SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR NO 2
BY WJV DATE 2-6-79 PROJ. NO. 78-617-215
CHKD. BY ____ DATE ____ SHEET NO. A OF ____

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HUTCHINSON DAMS #1, #2, AND #3
OVERTOPPING ANALYSIS
(W/ ARTIFICIALLY INCREASED STIRAGE FOR RESERVOIR #2)

SUMMARY INPUT/OUTPUT

```
DAM SAFETY INSPECTION PENNSYLVANIA 214 AND 215
HUTCHINSON RESERVOIRS #1 AND #2 ( W/ US ANALYSIS OF RESERVOIR #3)
5-MINUTE TIME STEP AND 24-HOUR STORM DURATION

                    JOB SPECIFICATION
  NU     NHR     NMIN     IDAY     IHR     IMIN    METRC     IPLT     IPRT    NSTAN
 200       0        5        0       0        0        0        0        0        0
                          JOPER     NWT   LROPT   TRACE
                              5       0       0       0


                MULTI-PLAN ANALYSES TO BE PERFORMED
                    NPLAN= 1 NRTIO= 4 LRTIO= 1
          RTIOS=    .20    .30    .40   1.00


**********      **********      **********      **********      **********

                    SUB-AREA RUNOFF COMPUTATION

     INFLOW TO RESERVOIR #3

                ISTAO   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                    3       0       0       0       0       0       1       0       0

                    HYDROGRAPH DATA
    IHYDG    IUNG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISAME   LOCAL
        1       1    1.90    0.00    1.90    0.00   0.000       1       0

                    PRECIP DATA
            SPFE     PRS      R6      R12     R24     R48     R72     R96
            0.00   24.00  102.00  120.00  130.00    0.00    0.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS  .800

                    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    1.00     .05    0.00    0.00

                UNIT HYDROGRAPH DATA
            TP=  2.43    CP= .50    NTA=  0

                RECESSION DATA
            STRTQ=   -1.50    QRCSN=    -.05    RTIOR= 2.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=30.29 AND R=39.29 INTERVALS

     UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG=  2.44 HOURS, CP=  .50  VOL=  .98
    2.    6.   12.   20.   29.   39.   49.   61.   72.   85.
   97.  110.  124.  136.  152.  166.  180.  192.  204.  215.
  224.  233.  241.  247.  253.  257.  261.  263.  263.  262.
  257.  251.  245.  239.  233.  227.  221.  216.  210.  205.
  200.  195.  190.  185.  180.  176.  171.  167.  163.  159.
  155.  151.  147.  143.  140.  136.  133.  130.  126.  123.
  120.  117.  114.  111.  108.  106.  103.  100.   98.   95.
   93.   91.   88.   86.   84.   82.   80.   78.   76.   74.
   72.   70.   69.   67.   65.   64.   62.   60.   59.   57.
   56.   55.   53.   52.   51.   49.   48.   47.   46.   44.
```

SUBJECT DAM SAFETY INSPECTION

HUTCHINSON RESERVOIR Nº 2

BY WJV DATE 2-6-79 PROJ. NO. 78-617-215

CHKD. BY _____ DATE _____ SHEET NO. 8 OF _____

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RESERVOIR Nº 3 INFLOW HYDROGRAPHS

| HO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | END-OF-PERIOD FLOW COMP Q |
|---|---|---|---|---|---|---|
| | | SUM | 24.96 | 23.08 | 1.88 | 269274. |
| | | | ( 634.)( | 586.)( | 48.)( | 6841.33) |

PMF

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 3677. | 2814. | 1004. | 1004. | 269274. |
| CMS | 104. | 80. | 28. | 28. | 8188. |
| INCHES | | 13.78 | 19.85 | 19.85 | 19.85 |
| MM | | 349.93 | 499.20 | 499.20 | 499.20 |
| AC-FT | | 1395. | 1991. | 1991. | 1991. |
| THOUS CU M | | 1721. | 2455. | 2455. | 2455. |

0.3 PMF

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 1103. | 844. | 301. | 301. | 66707. |
| CMS | 31. | 24. | 9. | 9. | 2455. |
| INCHES | | 4.13 | 5.90 | 5.90 | 5.90 |
| MM | | 104.98 | 149.76 | 149.76 | 149.76 |
| AC-FT | | 419. | 597. | 597. | 597. |
| THOUS CU M | | 516. | 737. | 737. | 737. |

0.4 PMF

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 1471. | 1126. | 401. | 401. | 115610. |
| CMS | 42. | 32. | 11. | 11. | 3274. |
| INCHES | | 5.51 | 7.86 | 7.86 | 7.86 |
| MM | | 139.97 | 199.68 | 199.68 | 199.68 |
| AC-FT | | 558. | 796. | 796. | 796. |
| THOUS CU M | | 688. | 982. | 982. | 982. |

**********

HYDROGRAPH ROUTING

ROUTE THRU RESERVOIR =3

| ISTAO | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| 303 | 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 | 0. | -1 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| STAGE | 1375.50 | 1380.50 | 1385.50 | 1390.50 | 1395.50 | 1400.50 | 1405.50 | 1410.50 | 1420.50 |
| | 1430.50 | 1431.50 | 1432.50 | 1433.50 | 1433.50 | 1434.50 | 1435.50 | 1436.50 | 1437.50 |
| FLOW | 0.00 | 126.00 | 126.00 | 126.00 | 126.00 | 126.00 | 126.00 | 126.00 | 126.00 |
| | 126.00 | 279.00 | 622.00 | 883.00 | 1382.00 | 3630.00 | 6771.00 | 10511.00 | 14924.00 |
| CAPACITY= | 0. | 3. | 11. | 25. | 45. | 70. | 100. | 137. | 226. | 440. |
| | 340. | 355. | 378. | 394. | 399. | 420. | 441. | 464. | 487. | |
| ELEVATION= | 1376. | 1381. | 1386. | 1391. | 1396. | 1401. | 1406. | 1411. | 1421. | 1426. |
| | 1431. | 1432. | 1433. | 1433. | 1434. | 1435. | 1436. | 1437. | 1438. | |

| CREL | SPWID | COOK | EXPW | ELEVI | COOL | CAREA | EXPL |
|---|---|---|---|---|---|---|---|
| 1430.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

DAM DATA

| TOPEL | COOD | EXPD | DAMWID |
|---|---|---|---|
| 1433.1 | 0.0 | 0.0 | 0. |

SUBJECT DAM SAFETY INSPECTION

HUTCHINSON RESERVOIR Nº 2

BY WJV DATE 2-6-79 PROJ. NO. 79-617-215

CHKD. BY ____ DATE ____ SHEET NO. C OF ____

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RESERVOIR Nº 3 OUTFLOW HYDROGRAPHS

PEAK OUTFLOW IS 3671. AT TIME 18.00 HOURS

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 3671. | 2745. | 808. | 808. | 237634. |
| CMS | 104. | 78. | 23. | 23. | 6587. |
| INCHES | | 13.44 | 15.82 | 15.82 | 15.82 |
| MM | | 341.40 | 401.80 | 401.80 | 401.80 |
| AC-FT | | 1361. | 1602. | 1602. | 1602. |
| THOUS CU M | | 1679. | 1976. | 1976. | 1976. |

PMF

PEAK OUTFLOW IS 511. AT TIME 21.50 HOURS

OVERTOPPING OCCURS @ APPROXIMATELY 0.37 PMF

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 511. | 301. | 121. | 121. | 34745. |
| CMS | 14. | 9. | 3. | 3. | 984. |
| INCHES | | 1.47 | 2.36 | 2.36 | 2.36 |
| MM | | 37.39 | 60.01 | 60.01 | 60.01 |
| AC-FT | | 149. | 239. | 239. | 239. |
| THOUS CU M | | 184. | 295. | 295. | 295. |

0.3 PMF

PEAK OUTFLOW IS 1194. AT TIME [illegible] HOURS

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 1194. | 681. | 218. | 218. | 62699. |
| CMS | 34. | 19. | 6. | 6. | 1761. |
| INCHES | | 3.34 | 4.28 | 4.28 | 4.28 |
| MM | | 84.73 | 108.64 | 108.64 | 108.64 |
| AC-FT | | 338. | 433. | 433. | 433. |
| THOUS CU M | | 417. | 534. | 534. | 534. |

0.4 PMF

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR =2

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

HYDROGRAPH DATA

| IHYDG | IUHG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | .09 | 0.00 | .09 | 0.00 | 0.000 | 0 | 1 | 0 |

PRECIP DATA

| SPFE | PB6 | R6 | R12 | R24 | R48 | R72 | R96 |
|---|---|---|---|---|---|---|---|
| 0.00 | 24.00 | 102.00 | 120.00 | 130.00 | 0.00 | 0.00 | 0.00 |

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

| LKOPT | STRKR | DLTKR | RTIOL | ERAIN | STRKS | RTIOR | STRTL | CNSTL | ALSMX | RTIMP |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 1.00 | .05 | 0.00 | 0.00 |

UNIT HYDROGRAPH DATA

TP= .77 CP= .50 NTA= 0

RECESSION DATA

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

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 9.92 AND R=12.57 INTERVALS

SUBJECT DAM SAFETY INSPECTION

HUTCHINSON RESERVOIR Nº 2

BY WTV DATE 2-6-79 PROJ. NO. 78-617-215

CHKD. BY ____ DATE ____ SHEET NO. D OF ____

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UNIT HYDROGRAPH 72 END-OF-PERIOD ORDINATES, LAG= .77 HOURS, CP= .50 VOL= 1.00

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 5. | 9. | 15. | 21. | 27. | 32. | 36. | 38. | 38. |
| 36. | 34. | 31. | 29. | 26. | 24. | 23. | 21. | 19. | 18. |
| 16. | 15. | 14. | 13. | 12. | 11. | 10. | 9. | 9. | 8. |
| 7. | 7. | 6. | 6. | 5. | 5. | 5. | 4. | 4. | 4. |
| 3. | 3. | 3. | 3. | 2. | 2. | 2. | 2. | 2. | 2. |
| 2. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. |
| 1. | 1. | 1. | 1. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | | | | | | | | |

| O HO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | END-OF-PERIOD FLOW COMP Q | HO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | SUM | 24.96 | 23.08 | 1.88 | 15859. |
| | | | | | | | | | | ( 634.)( | 586.)( | 48.)( | 449.08) |

RESERVOIR Nº 2 — PMF

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 322. | 171. | 55. | 55. | 15859. |
| CMS | 9. | 5. | 2. | 2. | 449. |
| INCHES | | 17.72 | 22.77 | 22.77 | 22.77 |
| MM | | 450.06 | 578.28 | 578.28 | 578.28 |
| AC-FT | | 85. | 109. | 109. | 109. |
| THOUS CU M | | 105. | 135. | 135. | 135. |

LOCAL HYDROGRAPHS — 0.2 PMF

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 64. | 34. | 11. | 11. | 3172. |
| CMS | 2. | 1. | 0. | 0. | 90. |
| INCHES | | 3.54 | 4.55 | 4.55 | 4.55 |
| MM | | 90.02 | 115.66 | 115.66 | 115.66 |
| AC-FT | | 17. | 22. | 22. | 22. |
| THOUS CU M | | 21. | 27. | 27. | 27. |

0.3 PMF

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 97. | 51. | 17. | 17. | 4756. |
| CMS | 3. | 1. | 0. | 0. | 135. |
| INCHES | | 5.32 | 6.83 | 6.83 | 6.83 |
| MM | | 135.02 | 173.48 | 173.48 | 173.48 |
| AC-FT | | 26. | 33. | 33. | 33. |
| THOUS CU M | | 31. | 40. | 40. | 40. |

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

COMBINE RES. =3 OUTFLOW W/ AREA =2 RUNOFF FOR INFLOW INTO RESERVOIR =2

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| 2 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 2
BY WJV DATE 2-6-79 PROJ. NO. 79-617-215
CHKD. BY DATE SHEET NO. E OF

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RESERVOIR Nº2 INFLOW HYDROGRAPHS

PMF

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 3846. | 2855. | 863. | 863. | 248493. |
| CMS | 109. | 81. | 24. | 24. | 7037. |
| INCHES | | 13.35 | 16.13 | 16.13 | 16.13 |
| MM | | 339.04 | 409.78 | 409.78 | 409.78 |
| AC-FT | | 1410. | 1711. | 1711. | 1711. |
| THOUS CU M | | 1747. | 2111. | 2111. | 2111. |

0.2 PMF

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 190. | 160. | 82. | 82. | 23630. |
| CMS | 5. | 5. | 2. | 2. | 669. |
| INCHES | | .75 | 1.53 | 1.53 | 1.53 |
| MM | | 19.03 | 38.97 | 38.97 | 38.97 |
| AC-FT | | 79. | 163. | 163. | 163. |
| THOUS CU M | | 98. | 201. | 201. | 201. |

0.3 PMF

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 515. | 314. | 137. | 137. | 39503. |
| CMS | 15. | 9. | 4. | 4. | 1119. |
| INCHES | | 1.47 | 2.56 | 2.56 | 2.56 |
| MM | | 37.30 | 65.14 | 65.14 | 65.14 |
| AC-FT | | 156. | 272. | 272. | 272. |
| THOUS CU M | | 192. | 336. | 336. | 336. |

**********  **********  **********  **********  **********

HYDROGRAPH ROUTING

ROUTE THRU RESERVOIR =2

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| 202 | 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 | 121. | -1 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| STAGE | 1345.00 | 1346.00 | 1347.00 | 1347.60 | 1347.70 | 1347.80 | 1348.00 | 1346.20 | 1348.40 |
| | 1348.60 | 1349.00 | 1349.20 | 1349.30 | | | | | |
| FLOW | 0.00 | 14.00 | 206.00 | 378.00 | 417.00 | 456.00 | 533.00 | 754.00 | 975.00 |
| | 1416.00 | 1637.00 | 2182.00 | 2455.00 | | | | | |
| CAPACITY= | 0. | 121. | 123. | 131. | 136. | 137. | 138. | 140. | 142. | 145. |
| | 147. | 151. | 159. | 300. | 500. | | | | |
| ELEVATION= | 1299. | 1346. | 1346. | 1347. | 1348. | 1348. | 1346. | 1348. | 1348. |
| | 1349. | 1349. | 1349. | 1349. | 1349. | | | | |

| CREL | SPWID | COOW | EXPW | ELEVL | COOL | CAREA | EXPL |
|---|---|---|---|---|---|---|---|
| 1345.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

DAM DATA

| TOPEL | COOD | EXPD | DAMWID |
|---|---|---|---|
| 1347.6 | 0.0 | 0.0 | 0. |

SUBJECT DAM SAFETY INSPECTION

HUTCHINSON RESERVOIR Nº 2

BY WTV DATE 2-6-79 PROJ. NO. 78-617-215

CHKD. BY ____ DATE ____ SHEET NO. ____F____ OF ____

GEI CONSULTANTS, I

Engineers • Geologists • Planners
Environmental Specialists

RESERVOIR Nº 2 OUTFLOW HYDROGRAPHS

OVERTOPPING OCCURS @ 0.27 PMF.

PEAK OUTFLOW IS 2400. AT TIME 20.58 HOURS

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 2400. | 2285. | 759. | 759. | 218500. |
| CMS | 66. | 65. | 21. | 21. | 6184. |
| INCHES | | 10.88 | 14.19 | 14.19 | 14.19 |
| MM | | 271.24 | 360.42 | 360.42 | 360.42 |
| AC-FT | | 1133. | 1505. | 1505. | 1505. |
| THOUS CU M | | 1397. | 1857. | 1857. | 1857. |

PMF

PEAK OUTFLOW IS 181. AT TIME 18.75 HOURS

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 181. | 159. | 79. | 79. | 22644. |
| CMS | 5. | 5. | 2. | 2. | 641. |
| INCHES | | .74 | 1.47 | 1.47 | 1.47 |
| MM | | 18.92 | 37.34 | 37.34 | 37.34 |
| AC-FT | | 79. | 156. | 156. | 156. |
| THOUS CU M | | 97. | 192. | 192. | 192. |

0.2 PMF

PEAK OUTFLOW IS 497. AT TIME 21.92 HOURS

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 497. | 307. | 131. | 131. | 37627. |
| CMS | 14. | 9. | 4. | 4. | 1065. |
| INCHES | | 1.44 | 2.44 | 2.44 | 2.44 |
| MM | | 36.45 | 62.05 | 62.05 | 62.05 |
| AC-FT | | 152. | 259. | 259. | 259. |
| THOUS CU M | | 188. | 320. | 320. | 320. |

0.3 PMF

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR =1

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

HYDROGRAPH DATA

| IHYDG | IUNG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | .43 | 0.00 | .43 | 0.00 | 0.000 | 0 | 1 | 0 |

PRECIP DATA

| SPFE | PMS | R6 | R12 | R24 | R48 | R72 | R96 |
|---|---|---|---|---|---|---|---|
| 0.00 | 24.00 | 102.00 | 120.00 | 130.00 | 0.00 | 0.00 | 0.00 |

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

| LKOPT | STRKR | DLTKR | RTIOL | ERAIN | STRKS | RTIOR | STRTL | CNSTL | ALSMX | RTIMP |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 1.00 | .05 | 0.00 | 0.00 |

UNIT HYDROGRAPH DATA

TP= 1.41 CP= .50 NTA= 0

SUBJECT DAM SAFETY INSPECTION

HUTCHINSON RESERVOIR Nº 2

BY WJV DATE 2-6-79 PROJ.NO. 78-617-215

CHKD.BY ____ DATE ____ SHEET NO. 6 OF ____

GEI CONSULTANTS, I

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Environmental Specialists

RECESSION DATA

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

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=17.66 AND R=23.16 INTERVALS

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 1.40 HOURS, CP= .50 VOL= .98

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 5. | 10. | 17. | 24. | 32. | 41. | 50. | 59. | 68. |
| 76. | 83. | 89. | 94. | 98. | 100. | 101. | 100. | 96. | 92. |
| 88. | 85. | 81. | 78. | 74. | 71. | 68. | 65. | 63. | 60. |
| 57. | 55. | 53. | 50. | 48. | 46. | 44. | 42. | 41. | 39. |
| 37. | 36. | 34. | 33. | 31. | 30. | 29. | 28. | 26. | 25. |
| 24. | 23. | 22. | 21. | 20. | 20. | 19. | 18. | 17. | 16. |
| 16. | 15. | 14. | 14. | 13. | 13. | 12. | 12. | 11. | 11. |
| 10. | 10. | 9. | 9. | 9. | 8. | 8. | 8. | 7. | 7. |
| 7. | 6. | 6. | 6. | 6. | 5. | 5. | 5. | 5. | 4. |
| 4. | 4. | 4. | 4. | 4. | 3. | 3. | 3. | 3. | 3. |

| 0 MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | END-OF-PERIOD FLOW COMP Q | MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | SUM | 24.96 | 23.08 | 1.88 | 73644. |
| | | | | | | | | | | ( 634.)( 586.)( 48.)( 2091.03) | | | |

RESERVOIR Nº 1 LOCAL HYDROGRAPHS

PMF

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 1119. | 745. | 256. | 256. | 73819. |
| CMS | 32. | 21. | 7. | 7. | 2090. |
| INCHES | | 16.11 | 22.18 | 22.18 | 22.18 |
| MM | | 409.28 | 563.36 | 563.36 | 563.36 |
| AC-FT | | 369. | 508. | 508. | 508. |
| THOUS CU M | | 456. | 627. | 627. | 627. |

0.2 PMF

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 224. | 149. | 51. | 51. | 14764. |
| CMS | 6. | 4. | 1. | 1. | 418. |
| INCHES | | 3.22 | 4.44 | 4.44 | 4.44 |
| MM | | 81.86 | 112.67 | 112.67 | 112.67 |
| AC-FT | | 74. | 102. | 102. | 102. |
| THOUS CU M | | 91. | 125. | 125. | 125. |

0.3 PMF

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 336. | 223. | 77. | 77. | 22146. |
| CMS | 10. | 6. | 2. | 2. | 627. |
| INCHES | | 4.83 | 6.65 | 6.65 | 6.65 |
| MM | | 122.78 | 169.01 | 169.01 | 169.01 |
| AC-FT | | 111. | 153. | 153. | 153. |
| THOUS CU M | | 137. | 188. | 188. | 188. |

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

COMBINE ADJUSTED PES. =2 OUTFLOW W/ AREA =1 RUNOFF FOR INFLOW TO RESERVOIR =1

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

SUBJECT DAM SAFETY INSPECTION

HUTCHINSON RESERVOIR Nº 2

BY WJV DATE 2-6-79 PROJ. NO. 78-617-215

CHKD. BY _____ DATE _____ SHEET NO. 4 OF _____

GEI CONSULTANTS, I

Engineers • Geologists • Planners
Environmental Specialists

RESERVOIR Nº 1 INFLOW HYDROGRAPHS

PMF

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 3068. | 2811. | 1015. | 1015. | 292379. |
| CMS | 87. | 80. | 29. | 29. | 8279. |
| INCHES | | 10.81 | 15.61 | 15.61 | 15.61 |
| MM | | 274.47 | 396.48 | 396.48 | 396.48 |
| AC-FT | | 1394. | 2014. | 2014. | 2014. |
| THOUS CU M | | 1719. | 2484. | 2484. | 2484. |

0.2 PMF

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 404. | 308. | 130. | 130. | 37407. |
| CMS | 11. | 9. | 4. | 4. | 1059. |
| INCHES | | 1.18 | 2.00 | 2.00 | 2.00 |
| MM | | 30.09 | 50.73 | 50.73 | 50.73 |
| AC-FT | | 153. | 258. | 258. | 258. |
| THOUS CU M | | 188. | 318. | 318. | 318. |

0.3 PMF

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 555. | 443. | 208. | 208. | 59773. |
| CMS | 16. | 13. | 6. | 6. | 1693. |
| INCHES | | 1.70 | 3.19 | 3.19 | 3.19 |
| MM | | 43.28 | 81.06 | 81.06 | 81.06 |
| AC-FT | | 220. | 412. | 412. | 412. |
| THOUS CU M | | 271. | 508. | 508. | 508. |

**********  **********  **********  **********  **********

HYDROGRAPH ROUTING

ROUTE THRU RESERVOIR #1

| ISTAO | ICOMP | IECON | ITAPE | JPLT | JPNT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| 101 | 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 | ISK | STORA | ISPRAT |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | 45. | -1 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| STAGE | 1291.60 | 1292.00 | 1292.50 | 1293.00 | 1293.50 | 1294.00 | 1294.30 | 1295.00 | 1295.50 |
| | 1297.00 | 1298.00 | 1299.00 | | | | | | |
| FLOW | 0.00 | 10.00 | 176.00 | 261.00 | 380.00 | 515.00 | 622.00 | 1386.00 | 2215.00 |
| | 5527.00 | 8300.00 | 11474.00 | | | | | | |
| CAPACITY= | 0. | 45. | 46. | 50. | 54. | 56. | 59. | 64. | 69. | 74. |
| | 80. | | | | | | | | |
| ELEVATION= | 1255. | 1292. | 1292. | 1293. | 1294. | 1294. | 1295. | 1296. | 1297. | 1298. |
| | 1299. | | | | | | | | |

| CREL | SPWID | COQW | EXPW | ELEVL | COQL | CAREA | EXPL |
|---|---|---|---|---|---|---|---|
| 1291.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

DAM DATA

| TOPEL | COQD | EXPD | DAMWID |
|---|---|---|---|
| 1294.3 | 0.0 | 0.0 | 0. |

SUBJECT DAM SAFETY INSPECTION

HUTCHINSON RESERVOIR Nº 2

BY WJV DATE 2-6-79 PROJ. NO. 79-617-215

CHKD. BY ____ DATE ____ SHEET NO. I OF ____

GAI CONSULTANTS, Inc.

Engineers • Geologists • Planners
Environmental Specialists

RESERVOIR Nº 1 OUTFLOW HYDROGRAPHS

OVERTOPPING OCCURS @ 0.33 PMF

PEAK OUTFLOW IS 3068. AT TIME 18.42 HOURS

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 3068. | 2811. | 1007. | 1007. | 290111. |
| CMS | 87. | 80. | 29. | 29. | 8215. |
| INCHES | | 10.81 | 15.49 | 15.49 | 15.49 |
| MM | | 274.50 | 393.41 | 393.41 | 393.41 |
| AC-FT | | 1394. | 1998. | 1998. | 1998. |
| THOUS CU M | | 1720. | 2465. | 2465. | 2465. |

PMF

PEAK OUTFLOW IS 551. AT TIME 22.00 HOURS

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 551. | 443. | 204. | 204. | 58849. |
| CMS | 16. | 13. | 6. | 6. | 1666. |
| INCHES | | 1.70 | 3.14 | 3.14 | 3.14 |
| MM | | 43.25 | 79.80 | 79.80 | 79.80 |
| AC-FT | | 220. | 405. | 405. | 405. |
| THOUS CU M | | 271. | 500. | 500. | 500. |

0.3 PMF

PEAK OUTFLOW IS 1242. AT TIME 19.75 HOURS

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 1242. | 916. | 346. | 346. | 99504. |
| CMS | 35. | 26. | 10. | 10. | 2818. |
| INCHES | | 3.52 | 5.31 | 5.31 | 5.31 |
| MM | | 89.42 | 134.93 | 134.93 | 134.93 |
| AC-FT | | 454. | 685. | 685. | 685. |
| THOUS CU M | | 560. | 845. | 845. | 845. |

0.4 PMF

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

DOWNSTREAM CHANNEL ROUTING FROM RESERVOIR =1 TO SECTION 7

| ISTAO | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| 107 | 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 | NSTOL | LAG | AMSKK | X | TSK | STORA | ISPRAT |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | 0. | 0 |

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR NO 2
BY WJV DATE 2-6-79 PROJ. NO. 78-617-215
CHKD. BY ____ DATE ____ SHEET NO. J OF ____

GJI CONSULTANTS, Inc.
Engineers • Geologists • Planners
Environmental Specialists

NORMAL DEPTH CHANNEL ROUTING

| QN(1) | QN(2) | QN(3) | ELNVT | ELMAX | RLNTH | SEL |
|---|---|---|---|---|---|---|
| .1250 | .0450 | .1000 | 1252.0 | 1298.0 | 250. | .05000 |

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1300.00 63.00 1260.00 160.00 1256.00 165.00 1252.00 180.00 1252.00
183.00 1256.00 312.00 1280.00 375.00 1300.00

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| STORAGE | 0.00 | .24 | .57 | 1.15 | 2.06 | 3.28 | 4.82 | 6.68 | 8.85 |
| | 14.14 | 17.26 | 20.69 | 24.35 | 28.22 | 32.30 | 36.60 | 41.10 | 45.82 |
| OUTFLOW | 0.00 | 463.36 | 1667.88 | 3785.99 | 6951.84 | 11341.79 | 17116.20 | 24425.50 | 33412.80 |
| | 56962.53 | 71784.47 | 89195.65 | 109307.03 | 131613.63 | 156160.56 | 182995.99 | 212170.27 | 243735.18 |
| STAGE | 1252.00 | 1254.42 | 1256.84 | 1259.26 | 1261.68 | 1264.11 | 1266.53 | 1268.95 | 1271.37 |
| | 1276.21 | 1278.63 | 1281.05 | 1283.47 | 1285.89 | 1288.32 | 1290.74 | 1293.16 | 1295.58 |
| FLOW | 0.00 | 463.36 | 1667.88 | 3785.99 | 6951.84 | 11341.79 | 17116.20 | 24425.50 | 33412.80 |
| | 56962.53 | 71784.47 | 89195.65 | 109307.03 | 131613.63 | 156160.56 | 182995.99 | 212170.27 | 243735.18 |

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 3066. | 2611. | 1007. | 1007. | 29[illegible]. |
| CMS | 87. | 80. | 29. | 29. | 8212. |
| INCHES | | 10.81 | 15.48 | 15.48 | 15.48 |
| MM | | 274.50 | 393.27 | 393.27 | 393.27 |
| AC-FT | | 1394. | 1997. | 1997. | 1997. |
| THOUS CU M | | 1720. | 2464. | 2464. | 2464. |

MAXIMUM STORAGE = 1.

MAXIMUM STAGE IS 1258.4

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR NO 2
BY WJV DATE 2-6-79 PROJ. NO. 79-617-215
CHKD. BY ____ DATE ____ SHEET NO. K OF ____

UGI CONSULTANTS, I
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********** ********** ********** ********** **********

HYDROGRAPH ROUTING

DOWNSTREAM CHANNEL ROUTING FROM SECTION 7 TO SECTION 8

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| 708 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ROUTING DATA

| OLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | | LSTR |
|---|---|---|---|---|---|---|---|---|
| 0.0 | 0.000 | 0.00 | 1 | 1 | 0 | 0 | | 0 |

| NSTPS | NSTOL | LAG | AMSKK | X | TSK | STORA | ISPRAT |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | 0. | 0 |

NORMAL DEPTH CHANNEL ROUTING

| QN(1) | QN(2) | QN(3) | ELEVI | ELMAX | ELMIN | SEL |
|---|---|---|---|---|---|---|
| .1000 | .0450 | .0800 | 1206.0 | 1260.0 | 1250. | .03300 |

CROSS SECTION COORDINATES -- STA,ELEV,STA,ELEV,ETC

0.00 1260.00 87.00 1240.00 360.00 1210.00 363.00 1206.00 378.00 1206.00
386.00 1212.00 590.00 1240.00 772.00 1260.00

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| STORAGE | 0.00 | 1.35 | 3.32 | 6.11 | 16.69 | 29.68 | 46.46 | 67.25 | 92.04 |
| | 153.64 | 190.44 | 231.24 | 275.44 | 322.53 | 372.51 | 425.37 | 481.12 | 539.75 |
| OUTFLOW | 0.00 | 475.58 | 1552.29 | 3715.40 | 7667.73 | 14022.98 | 23313.75 | 36022.02 | 52595.25 |
| | 99001.67 | 129620.01 | 165757.17 | 209683.11 | 259540.65 | 315503.46 | 377754.74 | 446483.41 | 521881.73 |
| STAGE | 1206.00 | 1208.84 | 1211.68 | 1214.53 | 1217.37 | 1220.21 | 1223.05 | 1225.89 | 1228.74 |
| | 1234.42 | 1237.26 | 1240.11 | 1242.95 | 1245.79 | 1248.63 | 1251.47 | 1254.32 | 1257.16 |
| FLOW | 0.00 | 475.58 | 1552.29 | 3715.40 | 7667.73 | 14022.98 | 23313.75 | 36022.02 | 52595.25 |
| | 99001.67 | 129620.01 | 165757.17 | 209683.11 | 259540.65 | 315503.46 | 377754.74 | 446483.41 | 521881.73 |

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 3067. | 2611. | 1005. | 1005. | 269352. |
| CMS | 87. | 80. | 28. | 28. | 8194. |
| INCHES | | 10.81 | 15.45 | 15.45 | 15.45 |
| MM | | 274.47 | 392.38 | 392.38 | 392.38 |
| AC-FT | | 1394. | 1993. | 1993. | 1993. |
| THOUS CU M | | 1719. | 2458. | 2458. | 2458. |

PMF

MAXIMUM STORAGE = 7.

MAXIMUM STAGE IS 1213.7

SUBJECT DAM SAFETY INSPECTION

HUTCHINSON RESERVOIR Nº 2

BY WJV DATE 2-6-79 PROJ. NO. 78-617-215

CHKD. BY ____ DATE ____ SHEET NO. 1 OF ____

UJU CONSULTANTS, I

Engineers • Geologists • Planners
Environmental Specialists

## SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 1375.50 | 1430.50 | 1433.10 |
| STORAGE | 0. | 340. | 390. |
| OUTFLOW | 0. | 126. | 818. |

RESERVOIR Nº 3

| 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 |
|---|---|---|---|---|---|---|---|
| .20 | 1423.40 | 0.00 | 257. | 126. | 0.00 | 13.50 | 0.00 |
| .30 | 1432.18 | 0.00 | 372. | 511. | 0.00 | 21.50 | 0.00 |
| .40 | 1433.42 | .32 | 397. | 1194. | 2.17 | 19.67 | 0.00 |
| 1.00 | 1434.51 | 1.41 | 420. | 3671. | 7.58 | 18.08 | 0.00 |
| * 0.50 | 1433.66 | 0.56 | | 1748. | | | |

PLAN 1 .....

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 1345.80 | 1345.80 | 1347.60 |
| STORAGE | 121. | 121. | 136. |
| OUTFLOW | 0. | 0. | 378. |

RESERVOIR Nº 2

| 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 |
|---|---|---|---|---|---|---|---|
| .20 | 1346.87 | 0.00 | 130. | 181. | 0.00 | 16.75 | 0.00 |
| .30 | 1347.91 | .31 | 139. | 497. | 2.33 | 21.92 | 0.00 |
| .40 | 1348.47 | .87 | 145. | 1047. | 5.00 | 20.33 | 0.00 |
| 1.00 | 1349.28 | 1.68 | 460. | 2400. | 8.00 | 20.58 | 0.00 |
| * 0.50 | 1348.6 | 1.00 | | 1270. | | | |

PLAN 1 .....

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 1291.80 | 1291.80 | 1294.30 |
| STORAGE | 45. | 45. | 56. |
| OUTFLOW | 0. | 0. | 622. |

RESERVOIR Nº 1

| 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 |
|---|---|---|---|---|---|---|---|
| .20 | 1293.57 | 0.00 | 53. | 399. | 0.00 | 17.17 | 0.00 |
| .30 | 1294.10 | 0.00 | 55. | 551. | 0.00 | 22.00 | 0.00 |
| .40 | 1294.87 | .57 | 58. | 1242. | 5.25 | 19.17 | 0.00 |
| 1.00 | 1295.94 | 1.64 | 63. | 3068. | 9.50 | 18.42 | 0.00 |
| * 0.50 | 1295.0 | 0.70 | | 1550. | | | |

* INTERPOLATED VALUES

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 2

BY WJV DATE 2-6-79 PROJ. NO. 78-617-215

CHKD. BY _____ DATE _____ SHEET NO. M OF _____

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SECTION 7
250 FT DS
OF DAM Nº 1

PLAN 1 STATION 107

| RATIO | MAXIMUM FLOW,CFS | MAXIMUM STAGE,FT | TIME HOURS |
|---|---|---|---|
| .20 | 400. | 1254.0 | 17.17 |
| .30 | 551. | 1254.6 | 22.00 |
| .40 | 1241. | 1256.0 | 18.75 |
| 1.00 | 3068. | 1258.4 | 18.42 |
| * 0.50 | 1550. | 1256.6 | |

SECTION 8
1500 FT DS
OF DAM Nº 1

PLAN 1 STATION 708

| RATIO | MAXIMUM FLOW,CFS | MAXIMUM STAGE,FT | TIME HOURS |
|---|---|---|---|
| .20 | 400. | 1208.4 | 17.17 |
| .30 | 551. | 1209.0 | 22.00 |
| .40 | 1241. | 1210.3 | 18.75 |
| 1.00 | 3067. | 1213.7 | 18.50 |
| * 0.50 | 1550. | 1211.7 | |

* INTERPOLATED VALUES

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR NO 2
BY WJV DATE 2-6-79 PROJ. NO. 79-617-215
CKD. BY DATE SHEET NO. N OF

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BREACHING ANALYSIS
(SAME INPUT DATA AS FOR THE OVERTOPPING ANALYSIS W/ THE ADDITION OF THE BREACH CONDITIONS GIVEN HERE)

PLAN

DAM SAFETY INSPECTION PENNSYLVANIA 214 AND 215
HUTCHINSON RESERVOIRS #1 AND #2 ( W/ US ANALYSIS OF RESERVOIR #3)
BREACHING ANALYSIS

ROUTE THRU RESERVOIR #3

DAM DATA

| TOPEL | COOD | EXPD | DAM#ID |
|---|---|---|---|
| 1433.1 | 0.0 | 0.0 | 0. |

DAM BREACH DATA

| BR#ID | Z | ELBM | TFAIL | #SEL | FAILEL |
|---|---|---|---|---|---|
| 0. | .50 | 1377.10 | .25 | 1375.50 | 1433.10 |

(1)

BEGIN DAM FAILURE AT 18.25 HOURS

PEAK OUTFLOW IS 19572. AT TIME 18.50 HOURS

DAM BREACH DATA

| BR#ID | Z | ELBM | TFAIL | #SEL | FAILEL |
|---|---|---|---|---|---|
| 150. | 2.00 | 1377.10 | .25 | 1375.50 | 1433.10 |

(2)

BEGIN DAM FAILURE AT 18.25 HOURS

PEAK OUTFLOW IS 29691. AT TIME 18.37 HOURS

DAM BREACH DATA

| BR#ID | Z | ELBM | TFAIL | #SEL | FAILEL |
|---|---|---|---|---|---|
| 0. | .50 | 1377.10 | 4.00 | 1375.50 | 1433.10 |

(3)

BEGIN DAM FAILURE AT 18.25 HOURS

PEAK OUTFLOW IS 3138. AT TIME 20.42 HOURS

DAM BREACH DATA

| BR#ID | Z | ELBM | TFAIL | #SEL | FAILEL |
|---|---|---|---|---|---|
| 150. | 2.00 | 1377.10 | 4.00 | 1375.50 | 1433.10 |

(4)

BEGIN DAM FAILURE AT 18.25 HOURS

PEAK OUTFLOW IS 4330. AT TIME 18.75 HOURS

DAM BREACH DATA

| BR#ID | Z | ELBM | TFAIL | #SEL | FAILEL |
|---|---|---|---|---|---|
| 100. | 1.00 | 1377.10 | 2.00 | 1375.50 | 1433.00 |

(6)

BEGIN DAM FAILURE AT 18.50 HOURS

PEAK OUTFLOW IS 5996. AT TIME 18.63 HOURS

DAM BREACH DATA

| BR#ID | Z | ELBM | TFAIL | #SEL | FAILEL |
|---|---|---|---|---|---|
| 100. | 1.00 | 1377.10 | 2.00 | 1375.50 | 1433.10 |

(5)

BEGIN DAM FAILURE AT 18.25 HOURS

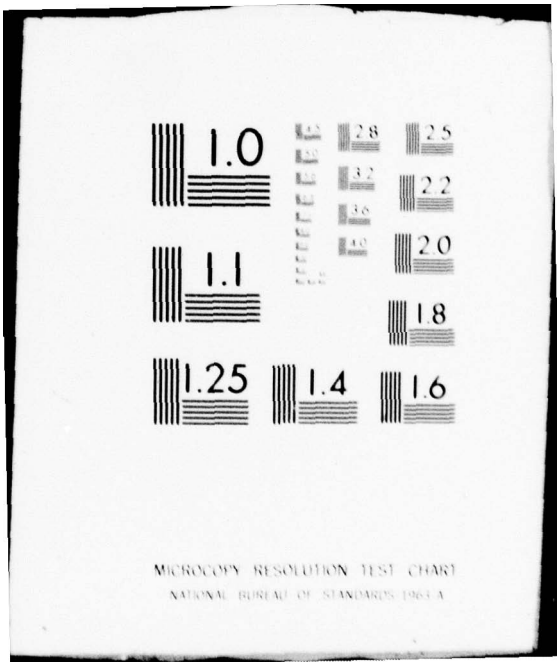
PEAK OUTFLOW IS 5997. AT TIME 18.63 HOURS

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NATIONAL DAM INSPECTION PROGRAM. HUTCHINSON RESERVOIR DAM NUMBE--ETC(U)
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2 OF 2
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

SUBJECT DAM SAFETY INSPECTION

HUTCHINSON RESERVOIR NO 2

BY WJV DATE 2-6-79 PROJ. NO. 79-617-215

CKD. BY DATE SHEET NO. 5 OF

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THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .042 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .083 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

| TIME (HOURS) | TIME FROM BEGINNING OF BREACH (HOURS) | INTERPOLATED BREACH HYDROGRAPH (CFS) | = | COMPUTED BREACH HYDROGRAPH (CFS) | ERROR (CFS) | ACCUMULATED ERROR (CFS) | ACCUMULATED ERROR (AC-FT) |
|---|---|---|---|---|---|---|---|
| 18.250 | 0.000 | 851. | | 851. | 0. | 0. | 0. |
| 18.292 | .042 | 1509. | | 1380. | 129. | 129. | 0. |
| 18.333 | .083 | 2167. | | 2167. | -0. | 129. | 0. |
| 18.375 | .125 | 2969. | | 2982. | -13. | 116. | 0. |
| 18.417 | .167 | 3771. | | 3771. | 0. | 116. | 0. |
| 18.458 | .208 | 4409. | | 4475. | -67. | 50. | 0. |
| 18.500 | .250 | 5046. | | 5046. | 0. | 50. | 0. |
| 18.542 | .292 | 5514. | | 5530. | -16. | 33. | 0. |
| 18.583 | .333 | 5982. | | 5982. | 0. | 33. | 0. |
| 18.625 | .375 | 5962. | | 5997. | -35. | -2. | -0. |
| 18.667 | .417 | 5941. | | 5941. | 0. | -2. | -0. |
| 18.708 | .458 | 5906. | | 5901. | 5. | 3. | 0. |
| 18.750 | .500 | 5871. | | 5871. | 0. | 3. | 0. |
| 18.792 | .542 | 5748. | | 5753. | -4. | -1. | -0. |
| 18.833 | .583 | 5626. | | 5626. | 0. | -1. | -0. |
| 18.875 | .625 | 5553. | | 5540. | 13. | 12. | 0. |
| 18.917 | .667 | 5480. | | 5480. | 0. | 12. | 0. |
| 18.958 | .708 | 5264. | | 5269. | -5. | 7. | 0. |
| 19.000 | .750 | 5048. | | 5048. | 0. | 7. | 0. |
| 19.042 | .792 | 4935. | | 4910. | 25. | 32. | 0. |
| 19.083 | .833 | 4822. | | 4822. | 0. | 32. | 0. |
| 19.125 | .875 | 4773. | | 4764. | 9. | 41. | 0. |
| 19.167 | .917 | 4724. | | 4724. | 0. | 41. | 0. |
| 19.208 | .958 | 4698. | | 4694. | 3. | 44. | 0. |
| 19.250 | 1.000 | 4672. | | 4672. | 0. | 44. | 0. |
| 19.292 | 1.042 | 4504. | | 4513. | -9. | 36. | 0. |
| 19.333 | 1.083 | 4336. | | 4336. | 0. | 36. | 0. |
| 19.375 | 1.125 | 4251. | | 4231. | 20. | 55. | 0. |
| 19.417 | 1.167 | 4166. | | 4166. | 0. | 55. | 0. |
| 19.458 | 1.208 | 3958. | | 3951. | 17. | 72. | 0. |
| 19.500 | 1.250 | 3749. | | 3749. | 0. | 72. | 0. |
| 19.542 | 1.292 | 3691. | | 3670. | 21. | 93. | 0. |
| 19.583 | 1.333 | 3613. | | 3613. | 0. | 93. | 0. |
| 19.625 | 1.375 | 3453. | | 3417. | 36. | 129. | 0. |
| 19.667 | 1.417 | 3292. | | 3292. | 0. | 129. | 0. |
| 19.708 | 1.458 | 3241. | | 3227. | 14. | 143. | 0. |
| 19.750 | 1.500 | 3190. | | 3190. | 0. | 143. | 0. |
| 19.792 | 1.542 | 3026. | | 2973. | 52. | 195. | 1. |
| 19.833 | 1.583 | 2862. | | 2862. | 0. | 195. | 1. |
| 19.875 | 1.625 | 2821. | | 2809. | 11. | 206. | 1. |
| 19.917 | 1.667 | 2780. | | 2780. | 0. | 206. | 1. |
| 19.958 | 1.708 | 2570. | | 2463. | 107. | 314. | 1. |
| 20.000 | 1.750 | 2361. | | 2361. | 0. | 314. | 1. |
| 20.042 | 1.792 | 2311. | | 2323. | -12. | 301. | 1. |
| 20.083 | 1.833 | 2261. | | 2261. | 0. | 301. | 1. |
| 20.125 | 1.875 | 2060. | | 1883. | 177. | 479. | 2. |
| 20.167 | 1.917 | 1859. | | 1859. | 0. | 479. | 2. |
| 20.208 | 1.958 | 1776. | | 1844. | -68. | 411. | 1. |
| 20.250 | 2.000 | 1693. | | 1693. | 0. | 411. | 1. |

(5)

Outflows w/o breach from overtopping analysis

-1286 = 991
-1558 = 2217
-1681 = 3365
-1732 = 4150
-1748 = 4193
-1746 = 4125
-1736 = 3890
-1722 = 3750
-1705 = 3843
-1686 = 3136

Approximate outflows due to breach

SUBJECT DAM SAFETY INSPECTION

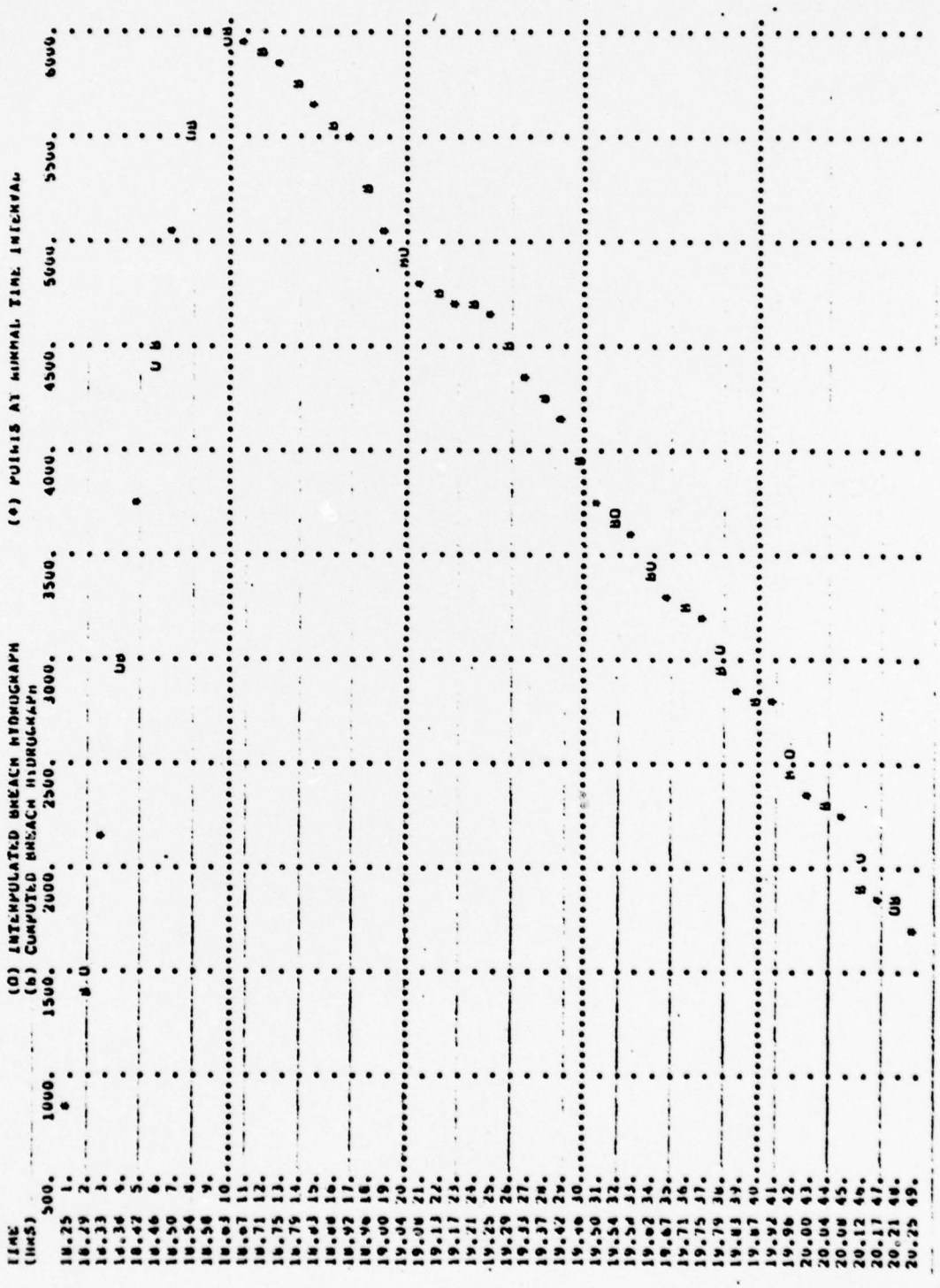
HUTCHINSON RESERVOIR Nº 2

BY WJV DATE 2-6-79 PROJ. NO. 79-617-215

CHKD. BY _____ DATE _____ SHEET NO. P OF _____

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SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 2

BY WJV DATE 2-6-79 PROJ. NO. 78-617-215

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PLAN

ROUTE THRU RESERVOIR #2

| | ISPEL | DAM DATA COOD | EXPD | DAMMID |
|---|---|---|---|---|
| | 1347.6 | 0.0 | 0.0 | 0. |

| | BRMID | Z | DAM BREACH DATA ELBM | TFAIL | WSEL | FAILEL |
|---|---|---|---|---|---|---|
| | 0. | .50 | 1300.00 | .25 | 1345.80 | 1347.00 |

① BEGIN DAM FAILURE AT 18.17 HOURS
PEAK OUTFLOW IS 15532. AT TIME 18.58 HOURS

| | BRMID | Z | DAM BREACH DATA ELBM | TFAIL | WSEL | FAILEL |
|---|---|---|---|---|---|---|
| | 100. | 4.00 | 1300.00 | .25 | 1345.80 | 1347.00 |

② BEGIN DAM FAILURE AT 18.17 HOURS
PEAK OUTFLOW IS 32691. AT TIME 18.37 HOURS

| | BRMID | Z | DAM BREACH DATA ELBM | TFAIL | WSEL | FAILEL |
|---|---|---|---|---|---|---|
| | 0. | .50 | 1300.00 | 4.00 | 1345.80 | 1347.00 |

③ BEGIN DAM FAILURE AT 18.17 HOURS
PEAK OUTFLOW IS 3762. AT TIME 20.42 HOURS

| | BRMID | Z | DAM BREACH DATA ELBM | TFAIL | WSEL | FAILEL |
|---|---|---|---|---|---|---|
| | 100. | 4.00 | 1300.00 | 4.00 | 1345.80 | 1347.00 |

④ BEGIN DAM FAILURE AT 18.17 HOURS
PEAK OUTFLOW IS 5235. AT TIME 18.75 HOURS

| | BRMID | Z | DAM BREACH DATA ELBM | TFAIL | WSEL | FAILEL |
|---|---|---|---|---|---|---|
| | 50. | 1.00 | 1300.00 | 2.00 | 1345.80 | 1346.10 |

⑥ BEGIN DAM FAILURE AT 18.33 HOURS
PEAK OUTFLOW IS 7597. AT TIME 18.92 HOURS

| | BRMID | Z | DAM BREACH DATA ELBM | TFAIL | WSEL | FAILEL |
|---|---|---|---|---|---|---|
| | 50. | 1.00 | 1300.00 | 2.00 | 1345.80 | 1347.00 |

⑤ BEGIN DAM FAILURE AT 18.17 HOURS
PEAK OUTFLOW IS 7734. AT TIME 18.75 HOURS

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 2

BY WJV DATE 2-6-79 PROJ. NO. 79-617-215

CKD. BY DATE SHEET NO. R OF

YBH CONSULTANTS, Engineers • Geologists • Planners Environmental Specialists

THE DAM BREACH HYDROGRAPH HAS DEVELOPED USING A TIME INTERVAL OF .042 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .083 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

| TIME (HOURS) | TIME FROM BEGINNING OF BREACH (HOURS) | INTERPOLATED BREACH HYDROGRAPH (CFS) | - COMPUTED BREACH HYDROGRAPH (CFS) | = ERROR (CFS) | ACCUMULATED ERROR (CFS) | ACCUMULATED ERROR (AC-FT) |
|---|---|---|---|---|---|---|
| | | | | APPROXIMATE DAM NO 3 BREACH OUTFLOWS (SEE SHEET 6) | | |
| 18.167 | 0.000 | 461. | 461. | 0. | 0. | 0. |
| 18.208 | .042 | 741. | 702. | 40. | 40. | 0. |
| 18.250 | .083 | 1022. | 1022. | 0. | 40. | 0. |
| 18.292 | .125 | 1498. | 1430. | 67. | 107. | 0. |
| 18.333 | .167 | 1914. | 1914. - 911 = 1003 | 0. | 107. | 0. |
| 18.375 | .208 | 2145. | 2082. | 64. | 171. | 1. |
| 18.417 | .250 | 3211. | 3317. - 2219 = 1098 | -0. | 171. | 1. |
| 18.458 | .292 | 4324. | 4353. | -29. | 142. | 0. |
| 18.500 | .333 | 5131. | -5131. - 3565 = 1566 | -0. | 142. | 0. |
| 18.542 | .375 | 5650. | 5959. | -109. | 32. | 0. |
| 18.583 | .417 | 6569. | -6569. - 4180 = 2389 | 0. | 32. | 0. |
| 18.625 | .458 | 7008. | 7089. | -81. | -48. | -0. |
| 18.667 | .500 | 7446. | -7494. - 4932 = 2562 | 0. | -48. | -0. |
| 18.708 | .542 | 7291. | 7820. | -35. | -83. | -0. |
| 18.750 | .583 | 7246. | -7730. - 4155 = 3575 | 0. | -83. | -0. |
| 18.792 | .625 | 7171. | 7133. | 38. | -45. | -0. |
| 18.833 | .667 | 6808. | -6808. - 3690 = 3118 | 0. | -45. | -0. |
| 18.875 | .708 | 6469. | 6421. | 47. | -2. | -0. |
| 18.917 | .750 | 6331. | -6331. - 3780 = 2551 | 0. | -2. | -0. |
| 18.958 | .792 | 6164. | 6195. | -32. | -34. | -0. |
| 19.000 | .833 | 5997. | -5997. - 3342 = 2654 | 0. | -34. | -0. |
| 19.042 | .875 | 5847. | 5825. | 23. | -11. | -0. |
| 19.083 | .917 | 5698. | -5698. - 3452 = 2246 | 0. | -11. | -0. |
| 19.125 | .958 | 5621. | 5605. | 16. | 5. | 0. |
| 19.167 | 1.000 | 5515. | 5515. | 0. | 5. | 0. |
| 19.208 | 1.042 | 5507. | 5501. APPROXIMATE | 0. | 11. | 0. |
| 19.250 | 1.083 | 5469. | 5469. OUTFLOWS | 0. | 11. | 0. |
| 19.292 | 1.125 | 5395. | 5388. DUE TO | -33. | -22. | -0. |
| 19.333 | 1.167 | 5281. | 5241. BREACHING | 0. | -22. | -0. |
| 19.375 | 1.208 | 5127. | 5109. OF DAM | 17. | -4. | -0. |
| 19.417 | 1.250 | 5014. | 5012. Nº 2 | 0. | -4. | -0. |
| 19.458 | 1.292 | 4857. | 4882. ONLY | -25. | -29. | -0. |
| 19.500 | 1.333 | 4702. | 4702. | 0. | -29. | -0. |
| 19.542 | 1.375 | 4579. | 4553. | 26. | -4. | -0. |
| 19.583 | 1.417 | 4436. | 4436. | 0. | -4. | -0. |
| 19.625 | 1.458 | 4320. | 4342. | -17. | -20. | -0. |
| 19.667 | 1.500 | 4196. | 4196. | 0. | -20. | -0. |
| 19.708 | 1.542 | 4102. | 4079. | 23. | 3. | 0. |
| 19.750 | 1.583 | 4007. | 4007. | 0. | 3. | 0. |
| 19.792 | 1.625 | 3888. | 3911. | -23. | -20. | -0. |
| 19.833 | 1.667 | 3806. | 3784. | 22. | -20. | -0. |
| 19.875 | 1.708 | 3679. | 3654. | 25. | 5. | 0. |
| 19.917 | 1.750 | 3589. | 3589. | 0. | 5. | 0. |
| 19.958 | 1.792 | 3450. | 3483. | -34. | -29. | -0. |
| 20.000 | 1.833 | 3310. | 3310. | 0. | -29. | -0. |
| 20.042 | 1.875 | 3198. | 3167. | 31. | 1. | 0. |
| 20.083 | 1.917 | 3085. | 3085. | 0. | 1. | 0. |
| 20.125 | 1.958 | 2941. | 2970. | -28. | -27. | -0. |
| 20.167 | 2.000 | 2809. | 2809. | 0. | -27. | -0. |

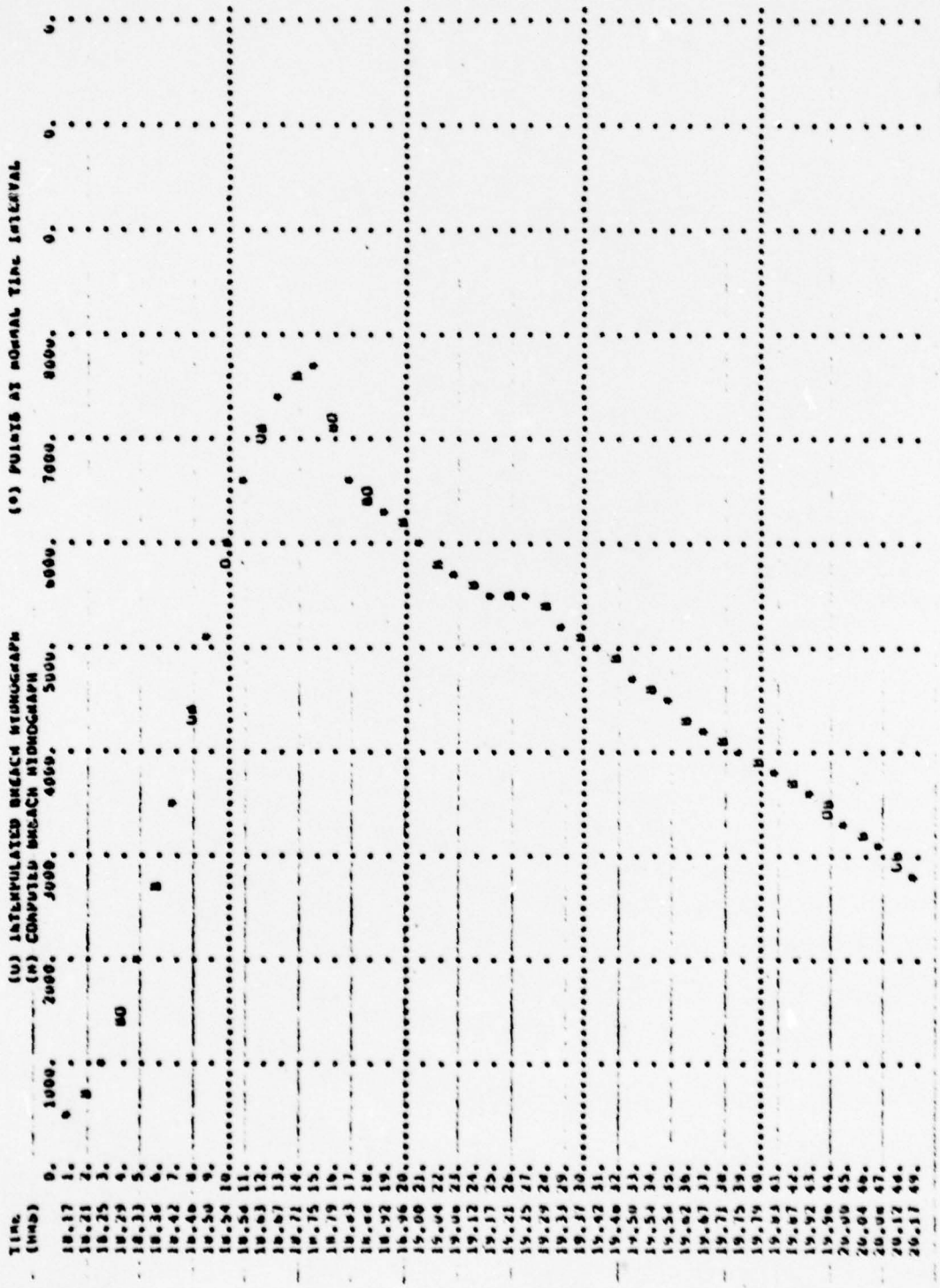
(5)

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 2

WJV DATE 2-6-79 PROJ. NO. 78-617-215

CHKD. BY _____ DATE _____ SHEET NO. 5 OF _____

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SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 2
WJV DATE 2-6-79 PROJ. NO. 79-617-215
CHKD. BY DATE SHEET NO. 7 OF

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ROUTE THRU RESERVOIR #1

| TOPEL | COOD | EXPO | DAMWID |
|---|---|---|---|
| 1294.3 | 0.0 | 0.0 | 0. |

DAM BREACH DATA

| BRWID | Z | ELBR | TFAIL | WSEL | FAILEL |
|---|---|---|---|---|---|
| 0. | .50 | 1261.30 | .25 | 1291.80 | 1294.30 |

(1) BEGIN DAM FAILURE AT 16.25 HOURS

PEAK OUTFLOW IS 15715. AT TIME 16.58 HOURS

DAM BREACH DATA

| BRWID | Z | ELBR | TFAIL | WSEL | FAILEL |
|---|---|---|---|---|---|
| 100. | 2.50 | 1261.30 | .25 | 1291.80 | 1294.30 |

(2) BEGIN DAM FAILURE AT 16.25 HOURS

PEAK OUTFLOW IS 33969. AT TIME 16.42 HOURS

DAM BREACH DATA

| BRWID | Z | ELBR | TFAIL | WSEL | FAILEL |
|---|---|---|---|---|---|
| 0. | .50 | 1261.30 | 4.00 | 1291.80 | 1294.30 |

(3) BEGIN DAM FAILURE AT 16.25 HOURS

PEAK OUTFLOW IS 3927. AT TIME 20.50 HOURS

DAM BREACH DATA

| BRWID | Z | ELBR | TFAIL | WSEL | FAILEL |
|---|---|---|---|---|---|
| 100. | 2.50 | 1261.30 | 4.00 | 1291.80 | 1294.30 |

(4) BEGIN DAM FAILURE AT 16.25 HOURS

PEAK OUTFLOW IS 5746. AT TIME 18.75 HOURS

DAM BREACH DATA

| BRWID | Z | ELBR | TFAIL | WSEL | FAILEL |
|---|---|---|---|---|---|
| 50. | 1.00 | 1261.30 | 1.00 | 1291.80 | 1294.80 |

(6) BEGIN DAM FAILURE AT 16.42 HOURS

PEAK OUTFLOW IS 8479. AT TIME 16.90 HOURS

DAM BREACH DATA

| BRWID | Z | ELBR | TFAIL | WSEL | FAILEL |
|---|---|---|---|---|---|
| 50. | 1.00 | 1261.30 | 1.00 | 1291.80 | 1294.30 |

(5) BEGIN DAM FAILURE AT 16.25 HOURS

PEAK OUTFLOW IS 8115. AT TIME 16.75 HOURS

SUBJECT DAM SAFETY INSPECTION

HUTCHINSON RESERVOIR Nº 2

WJV DATE 2-6-79 PROJ. NO. 78-617-215

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THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .021 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .083 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

| TIME (HOURS) | TIME FROM BEGINNING OF BREACH (HOURS) | INTERPOLATED BREACH HYDROGRAPH (CFS) | - | COMPUTED BREACH HYDROGRAPH (CFS) | = | ERROR (CFS) | ACCUMULATED ERROR (CFS) | ACCUMULATED ERROR (AC-FT) |
|---|---|---|---|---|---|---|---|---|
| 16.250 | 0.000 | 663. | | 663. | | 0. | 0. | 0. |
| 16.271 | .021 | 786. | | 754. | | 33. | 33. | 0. |
| 16.292 | .042 | 910. | | 873. | | 37. | 70. | 0. |
| 16.313 | .063 | 1034. | | 1020. | | 13. | 83. | 0. |
| 16.333 | .083 | 1157. | | 1157. | | -0. | 83. | 0. |
| 16.354 | .104 | 1275. | | 1296. | | -21. | 62. | 0. |
| 16.375 | .125 | 1393. | | 1420. | | -28. | 35. | 0. |
| 16.396 | .146 | 1511. | | 1532. | DUE TO | -21. | 13. | 0. |
| 16.417 | .167 | 1629. | | 1628. | BREACHING | 0. | 13. | 0. |
| 16.438 | .188 | 1590. | | 1711. | OF DAM | -121. | -107. | -0. |
| 16.458 | .208 | 1552. | | 1723. | #2 | -171. | -278. | -0. |
| 16.479 | .229 | 1514. | | 1738. | ONLY | -224. | -502. | -1. |
| 16.500 | .250 | 1475. | | 1475. | | 0. | -502. | -1. |
| 16.521 | .271 | 1429. | | 1366. | | 64. | -439. | -1. |
| 16.542 | .292 | 1383. | | 1318. | | 65. | -373. | -1. |
| 16.563 | .313 | 1337. | | 1298. | | 39. | -334. | -1. |
| 16.583 | .333 | 1291. | | 1291. | | 0. | -334. | -1. |
| 16.604 | .354 | 1293. | | 1290. | | 3. | -332. | -1. |
| 16.625 | .375 | 1294. | | 1292. | | 3. | -329. | -1. |
| 16.646 | .396 | 1296. | | 1294. | | 2. | -327. | -1. |
| 16.667 | .417 | 1297. | | 1297. | | 0. | -327. | -1. |
| 16.688 | .437 | 1300. | | 1300. | | -0. | -328. | -1. |
| 16.708 | .458 | 1302. | | 1303. | | -0. | -328. | -1. |
| 16.729 | .479 | 1305. | | 1305. | | -0. | -328. | -1. |
| 16.750 | .500 | 1306. | | 1308. | | 0. | -328. | -1. |
| 16.771 | .521 | 1310. | | 1310. | | -0. | -329. | -1. |
| 16.792 | .542 | 1311. | | 1312. | | -0. | -329. | -1. |
| 16.813 | .562 | 1313. | | 1314. | | -0. | -329. | -1. |
| 16.833 | .583 | 1315. | | 1315. | | 0. | -329. | -1. |
| 16.854 | .604 | 1316. | | 1316. | | -0. | -330. | -1. |
| 16.875 | .625 | 1316. | | 1317. | | -0. | -330. | -1. |
| 16.896 | .646 | 1317. | | 1317. | | -0. | -331. | -1. |
| 16.917 | .667 | 1318. | | 1318. | | 0. | -331. | -1. |
| 16.938 | .687 | 1317. | | 1318. | | -0. | -331. | -1. |
| 16.958 | .708 | 1317. | | 1317. | | -1. | -332. | -1. |
| 16.979 | .729 | 1316. | | 1317. | | -0. | -332. | -1. |
| 17.000 | .750 | 1316. | | 1316. | | 0. | -332. | -1. |
| 17.021 | .771 | 1315. | | 1315. | | -0. | -332. | -1. |
| 17.042 | .792 | 1313. | | 1314. | | -0. | -333. | -1. |
| 17.063 | .812 | 1312. | | 1312. | | -0. | -333. | -1. |
| 17.083 | .833 | 1310. | | 1310. | | 0. | -333. | -1. |
| 17.104 | .854 | 1308. | | 1308. | | -0. | -333. | -1. |
| 17.125 | .875 | 1306. | | 1306. | | -0. | -333. | -1. |
| 17.146 | .896 | 1304. | | 1304. | | -0. | -333. | -1. |
| 17.167 | .917 | 1302. | | 1302. | | 0. | -334. | -1. |
| 17.188 | .937 | 1300. | | 1300. | | -0. | -334. | -1. |
| 17.208 | .958 | 1297. | | 1297. | | -0. | -334. | -1. |
| 17.229 | .979 | 1295. | | 1295. | | -0. | -334. | -1. |
| 17.250 | 1.000 | 1292. | | 1292. | | 0. | -334. | -1. |

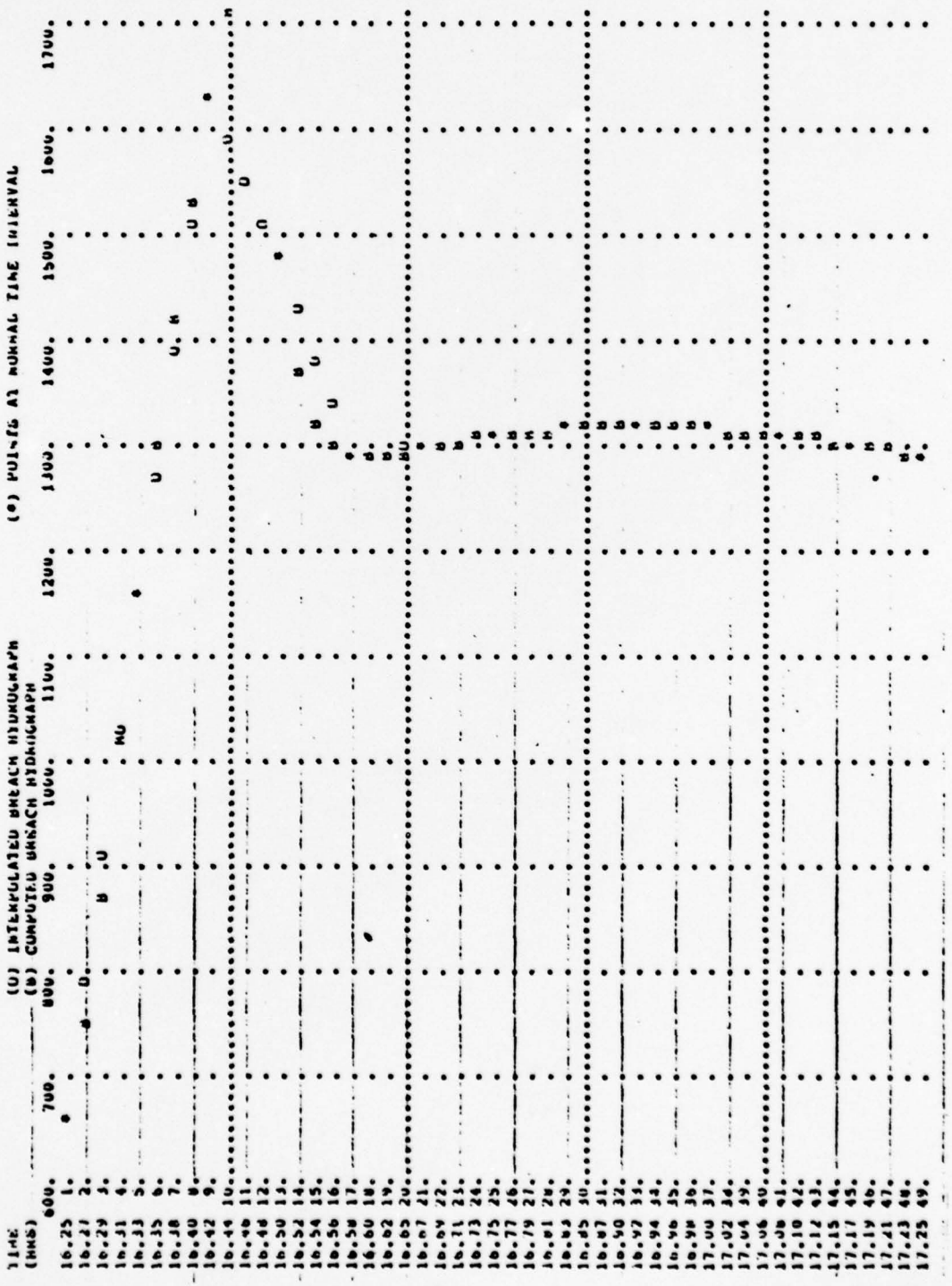
(5)

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 2

WJV DATE 2-6-79 PROJ. NO. 78-617-215

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HUTCHINSON RESERVOIR Nº 2

WTV DATE 2-6-79 PROJ. NO. 78-617-215

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RESERVOIR Nº 3

SUMMARY OF DAM SAFETY ANALYSIS

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 1375.50 | 1430.50 | 1433.10 |
| STORAGE | 0. | 340. | 390. |
| OUTFLOW | 0. | 120. | 818. |

| 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 | .50 | 1433.34 | .24 | 395. | 19572. | .19 | 18.50 | 18.25 |
| 2 | .50 | 1433.19 | .09 | 392. | 29691. | .10 | 18.37 | 18.25 |
| 3 | .50 | 1433.64 | .54 | 401. | 3136. | 1.17 | 20.42 | 18.25 |
| 4 | .50 | 1433.35 | .25 | 395. | 4330. | .25 | 18.75 | 18.25 |
| 5 | .50 | 1433.31 | .21 | 395. | 5997. | .21 | 18.63 | 18.25 |
| 6 | .50 | 1433.63 | .53 | 401. | 5996. | .46 | 18.83 | 18.50 |

RESERVOIR Nº 2

SUMMARY OF DAM SAFETY ANALYSIS

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 1345.80 | 1345.80 | 1347.80 |
| STORAGE | 121. | 121. | 136. |
| OUTFLOW | 0. | 0. | 378. |

| 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 | .50 | 1347.89 | .29 | 139. | 15532. | .19 | 18.58 | 18.17 |
| 2 | .50 | 1347.79 | .19 | 138. | 32481. | .10 | 18.37 | 18.17 |
| 3 | .50 | 1348.59 | .99 | 147. | 3762. | 2.00 | 20.42 | 18.17 |
| 4 | .50 | 1348.03 | .43 | 140. | 5255. | .50 | 18.75 | 18.17 |
| 5 | .50 | 1348.25 | .65 | 143. | 7734. | .54 | 18.75 | 18.17 |
| 6 | .50 | 1348.30 | .70 | 143. | 7597. | .56 | 18.92 | 18.33 |

RESERVOIR Nº 1

SUMMARY OF DAM SAFETY ANALYSIS

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 1291.80 | 1291.80 | 1294.30 |
| STORAGE | 45. | 45. | 56. |
| OUTFLOW | 0. | 0. | 622. |

| 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 | .50 | 1297.26 | 2.96 | 70. | 5715. | .48 | 18.58 | 18.25 |
| 2 | .50 | 1294.34 | .04 | 56. | 33969. | .49 | 18.42 | 18.25 |
| 3 | .50 | 1294.44 | .14 | 56. | 3927. | 1.00 | 20.50 | 18.25 |
| 4 | .50 | 1294.34 | .04 | 56. | 5726. | .17 | 18.75 | 18.25 |
| 5 | .50 | 1294.34 | .04 | 56. | 8115. | .10 | 18.75 | 18.25 |
| 6 | .50 | 1295.27 | .97 | 60. | 8479. | 2.52 | 18.90 | 18.42 |

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 2

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DOWNSTREAM CHANNEL ROUTING FROM RESERVOIR #1 TO SECTION 7

## SUMMARY

STATION 7

| PLAN | RATIO | MAXIMUM FLOW,CFS | MAXIMUM STAGE,FT | TIME HOURS |
|---|---|---|---|---|
| 1 | .50 | 13883. | 1266.0 | 18.58 |
| 2 | .50 | 24069. | 1271.6 | 16.42 |
| 3 | .50 | 3936. | 1259.4 | 24.50 |
| 4 | .50 | 5730. | 1260.8 | 18.83 |
| 5 | .50 | 8112. | 1262.3 | 18.75 |
| 6 | .50 | 6415. | 1261.5 | 18.92 |

DOWNSTREAM CHANNEL ROUTING FROM SECTION 7 TO SECTION 8

## SUMMARY

STATION 8

| PLAN | RATIO | MAXIMUM FLOW,CFS | MAXIMUM STAGE,FT | TIME HOURS |
|---|---|---|---|---|
| 1 | .50 | 16206. | 1220.9 | 18.58 |
| 2 | .50 | 24624. | 1225.6 | 17.42 |
| 3 | .50 | 3930. | 1214.7 | 20.50 |
| 4 | .50 | 5762. | 1216.0 | 18.83 |
| 5 | .50 | 8040. | 1217.5 | 18.75 |
| 6 | .50 | 6325. | 1217.7 | 18.92 |

# APPENDIX C-1

# SUPPLEMENTAL CALCULATIONS

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR DAM N° 3

BY DLB DATE 8-28-78 PROJ. NO. 78-617-216

CHKD. BY EJM DATE 9-13-78 SHEET NO. 1 OF 15

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## DAM STATISTICS

MAXIMUM HEIGHT ≃ 56 FEET (FIELD MEASURED)

MAXIMUM POOL STORAGE CAPACITY ≃ 390 AC-FT (SHEET 5)

NORMAL POOL STORAGE CAPACITY ≃ 340 AC-FT (SEE NOTE BELOW)

DRAINAGE AREA ≃ 1.9 SQ. MILES [PLANIMETERED OFF U.S.G.S. 7.5 MINUTE SERIES QUAD BROWNFIELD, PA.]

## SIZE CLASSIFICATION

DAM SIZE - INTERMEDIATE (REF 1, TABLE 1)

HAZARD CLASSIFICATION - HIGH (FIELD OBSERVATION)

REQUIRED SDF - PMF (REF 1, TABLE 3)

NOTE: THE VALUE OF STORAGE CAPACITY IS TAKEN FROM AN UNPUBLISHED NOTEBOOK CONTAINING PERTINANT DATA FOR DAMS OPERATED BY THE UNIONTOWN BRANCH OF W.P.W.. THE NOTEBOOK IS AVAILABLE FROM THE FILES LOCATED AT UNIONTOWN OFFICE OF W.P.W.

A COMPARISON OF THE CALCULATIONS PRESENTED IN THIS TEXT WITH THOSE PREVIOUSLY SUBMITTED IN THE REPORT ENTITLED "HUTCHINSON RESERVOIR NO.3 DAM", DATED SEPTEMBER 1978 WILL REVEAL SEVERAL DISCREPANCIES. THIS IS A DIRECT RESULT OF THE INCREASED ACCURACY REQUIRED TO SUCCESSFULLY COMPLETE THIS ANALYSIS ACCORDING TO THE REVISED GUIDELINES SET FORTH IN THIS CONTRACT. NEVERTHELESS, THE BOTTOM LINE END RESULT HAS REMAINED VIRTUALLY UNCHANGED.

SUBJECT DAM SAFETY INSPECTION.
HUTCHINSON RESERVOIR Nº 3

BY KHK DATE 10-13-78 PROJ. NO. 78-617-216

CHKD. BY RFJ DATE 10-18-78 SHEET NO. 2 OF 15

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## HUTCHINSON RESERVOIR # 3

DRAINAGE AREA. = 1.9 SQ. MILES (PLANIMETERED)

## SURFACE AREA

NORMAL POOL (ELEV. 1430.5)* = 0.20 SQ. INC (PLANIMETER)
= 18.36 ACRES

(THIS EXCEEDS SURFACE AREA OF 14.5 ACRES GIVEN in 3/14/74 LETTER FROM W.S. McCLAY to UNIONTOWN WATER CO., BUT CALCS. AND POOL LEVEL for 3/14/74 VALUE ARE NOT GIVEN. THEREFORE 18.36 ACRES WILL BE USED)

AREA AT CONTOUR 1440 = .28 SQ INC.
= 25.71 ACRES

$\frac{\Delta A}{\Delta Y}$ = RATE OF CHANGE IN AREA / FOOT RISE = $\frac{25.71 - 18.36}{1440 - 1430.5}$ = 0.77 AC/FT

FREE BOARD = 2.8 FT.

AREA AT THE TOP OF DAM ELEV. 1433.1 = 18.36 + 2.6 x .77
= 20.4 ACRE-

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 3

BY KHK DATE 10-20-78 PROJ. NO. 79-617-216

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* RIGHT ABUT. SPILLWAY IS 0.2' BELOW CREST OF LEFT ABUT. SPILLWAY. FROM UNIONTOWN WATER CO DWG 93-127. LT. ABUT. SPILLWAY CREST IS AT ELEVATION 1430.7'.

## UNIT HYDROGRAPH PARAMETERS

LENGTH OF LONGEST WATERCOURSE (L) ≃ 2.95 MILES

$L_{CA}$ ≃ 1.37 MILES

[VALUES OF L AND $L_{CA}$ ARE FROM U.S.G.S. 7.5 MINUTE SERIES QUAD BROWNFIELD, PA.

NOTE: ALL VARIABLES ARE DEFINED IN REFERENCE 2 IN THE SECTION ENTITLED "SNYDER SYNTHETIC UNIT HYDROGRAPH".

$C_t = 1.6$

$C_p = 0.5$

} [SUPPLIED BY C OF E; ZONE 29, OHIO RIVER BASIN

$t_p$ = SNYDER'S STANDARD LAG = $1.6 (L \times L_{CA})^{0.3}$

$t_p = (1.6)[(2.95)(1.37)]^{0.3} = 2.43$ HRS

## PMP CALCULATIONS

HUTCHINSON RESERVOIR #3 LOCATION ⇒ ZONE 7 (REF. 3)
PMP INDEX = 24 INCHES (FIG. 1, REF. 3)
DURATION % INDEX:

6 HRS = 102
12 HRS = 120
24 HRS = 130

NOTE: A 24-HOUR DURATION RATHER THAN A 48-HOUR DURATION WAS USED. THIS WAS NECESSITATED BY THE NEED TO USE A 5-MINUTE TIME STEP IN THE HEC-1-DAM PROGRAM IN ORDER TO MORE ACCURATELY DEFINE THE PEAKS OF THE HYDROGRAPH. (A MAXIMUM OF ONLY 300 TIME INTERVALS IS ALLOWED IN THE PROGRAM.)

SUBJECT DAM SAFETY INSPECTION.
HUTCHINSON RESERVOIR Nº 3

BY KHK DATE 10-25-78 PROJ. NO. 78-617-216.

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## APPROXIMATE ELEVATION @ ZERO STORAGE

VOLUME = $\frac{1}{3}$ HA (CONIC METHOD)

A = 18.4 ACRES (SHEET 2 OF CALCS).

NORMAL POOL VOLUME = 340 A-F (WPW FILES UNIONTOWN OFFICE)

$$H = \frac{340 \times 3}{18.4} = 55.43 \text{ FT.}$$

= USE 55 FT

NORMAL POOL ELEV = 1430.5 FT.

ZERO VOLUME ELEV = 1375.5 FT

FURTHER, THE RATE OF CHANGE OF SURFACE AREA PER FOOT OF RESERVOIR RISE BELOW ELEVATION 1430.5:

$$\left(\frac{\Delta A}{\Delta Y}\right)' = 18.4 \text{ ACRES} / 55 \text{ FT} = 0.335 \frac{\text{ACRES}}{\text{FT}}$$

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 3
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## ELEVATION - STORAGE RELATIONSHIP

- ESTIMATED SURFACE AREA: $A = A_o + \left(\frac{\Delta A}{\Delta Y}\right) Y$

$A_o$ = 18.4 ACRES ABOVE EL. 1430.5, AND 0.0 ACRES BELOW;

$\frac{\Delta A}{\Delta Y}$ = 0.77 AC/FT ABOVE EL. 1430.5, AND 0.335 AC/FT BELOW; AND

$Y$ = [(ELEVATION OF CONCERN) − 1430.5 FT] ABOVE 1430.5 FT AND [(ELEVATION OF CONCERN) − 1375.5 FT] BELOW

- ESTIMATED INCREMENTAL INCREASE IN STORAGE ABOVE EL. 1430.5 FT

MODIFIED PRISMOIDAL FORMULA: $\Delta V_{1-2} = \frac{Y}{3}\left(A_1 + A_2 + \sqrt{A_1 * A_2}\right)$
(REF. 14, PG 15)

- ESTIMATED STORAGE BELOW 1430.5 FT:

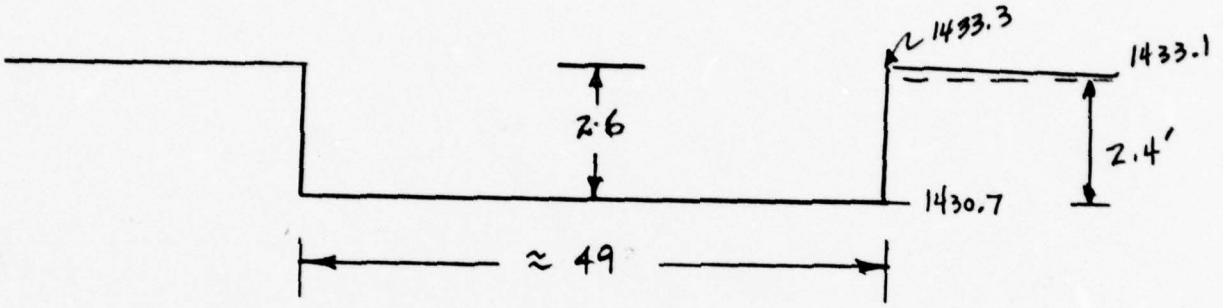
CONIC FORMULA: $V = \frac{1}{3} H A$ (where $H = Y$)

| ELEVATION (FT) | H (FT) | ESTIMATED AREA (ACRE) | ESTIMATED STORAGE (A-F) | ELEVATION (FT) | Y (FT) | ESTIMATED AREA (ACRE) | INCREMENTAL STORAGE (A-F) | CUMULATIVE STORAGE (A-F) |
|---|---|---|---|---|---|---|---|---|
| 1375.5 | 0 | 0 | 0 | 1431.5 | 1 | 19.2 | 18.8 | 358.8 |
| 1380.5 | 5 | 1.67 | 3 | 1432.5 | 2 | 19.9 | 19.5 | 378.3 |
| 1385.5 | 10 | 3.35 | 11 | 1433.3 | 2.8 | 20.6 | 16.1 | 394.4 |
| 1390.5 | 15 | 5.00 | 25 | 1433.5 | 3 | 20.7 | 4.1 | 398.5 |
| 1395.5 | 20 | 6.70 | 45 | 1434.5 | 4 | 21.5 | 21.1 | 419.6 |
| 1400.5 | 25 | 8.36 | 70 | 1435.5 | 5 | 22.3 | 21.8 | 441.4 |
| 1405.5 | 30 | 10.0 | 100 | 1436.5 | 6 | 23.0 | 22.6 | 464.0 |
| 1410.5 | 35 | 11.7 | 137 | 1437.5 | 7 | 23.8 | 23.4 | 487.4 |
| 1420.5 | 45 | 15.0 | 226 | | | | | |
| 1425.5 | 50 | 16.7 | 290 | | | | | |
| NORMAL POOL - 1430.5 | 55 | 18.4 | 340 | | | | | |

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 3
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# CAPACITY OF LEFT SPILLWAY




SUPERCRITICAL FLOW IS ASSUMED TO OCCUR IN THE SPILLWAY CHANNEL SINCE THE DOWNSTREAM SLOPE IS ABOUT 3% (FIELD MEASUREMENTS). THE CRITICAL SECTION, THAT SECTION WHERE FLOW IS TRANSFORMED FROM SUBCRITICAL TO SUPERCRITICAL FLOW IS ASSUMED TO BE AT THE SPILLWAY INLET.

LET $H_s$ = SPECIFIC ENERGY HEAD = $y + \frac{V^2}{2g}$ (REF. 13, PG 139)

IN RESERVOIR, V IS NEGLIGIBLE $\Rightarrow H_s = H = 2.4$ FT

AT SPILLWAY INLET $H_s = y_c + \frac{V_c^2}{2g}$ (CRITICAL CONDITIONS)

$\therefore y_c + \frac{V_c^2}{2g} = H$

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CRITICAL DEPTH IN RECTANGULAR CHANNEL $= \frac{V_c^2}{2g} = \frac{D_c}{2}$ (REF 13, PG. 143)

WHERE $D_c$ = HYDRAULIC DEPTH $= \frac{\text{AREA}}{\text{TOP WIDTH}} = \frac{A_c}{W_c}$.

$A_c = 49\, y_c$.

$W_c = 49'$

$$y_c + \frac{49\, y_c}{2 \times 49} = H = 2.4'$$

$$y_c + \frac{y_c}{2} = H = 2.4'$$

$$1.5\, y_c = 2.4' \qquad y_c = 1.60'$$

$$V_c^2/2g = \frac{D_c}{2} = \frac{49 \times 1.60}{2(49)} = 0.800$$

$$V_c^2 = 64.4 \times 0.800$$

$$V_c = 7.18 \text{ FPS.}$$

$$Q_c = V_c \times A_c = 7.18 \times 49 \times 1.60 =$$

$$= 563 \text{ CFS}$$

SUBJECT DAM SAFETY INSPECTION.
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DETERMINE THE CRITICAL SLOPE.

$$Q_c = \frac{1.49}{n} A_c R_c^{2/3} \sqrt{S_c}$$ (MANNING EQ, REF 13, PG 143)

OR $$S_c = \left( \frac{Q_c n}{1.49 A_c R_c^{2/3}} \right)^2$$

$$R_c = \frac{\text{AREA}}{\text{WETTED PERIMETER}} = \frac{49 \times 1.60}{49 + 2 \times 1.60} = 1.50'$$

$n = .014$ CONCRETE LINED (REF 7 PAGE 116)

$$S_c = \left( \frac{563 \times .014}{1.49 \times 78.40 \times (1.50)^{2/3}} \right)^2 = 0.00265$$

$$= 0.265\% < 3\%$$

CRITICAL SLOPE IS LESS THAN ACTUAL SLOPE; THUS SUPER CRITICAL FLOW DOES OCCUR IN THE SPILLWAY CHANNEL.

MAXIMUM SPILLWAY CAPACITY $Q = Q_c = 563$ CFS.

SUBJECT DAM SAFETY INSPECTION
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## ELEVATION DISCHARGE RELATIONSHIP FOR LEFT SPILLWAY

THE PROCEDURE USED TO CALCULATE THE SPILLWAY CAPACITY ON SHEETS 6 AND 7 WILL BE FOLLOWED TO DETERMINE THE DISCHARGE VALUES:

$$y_c = H/1.5$$

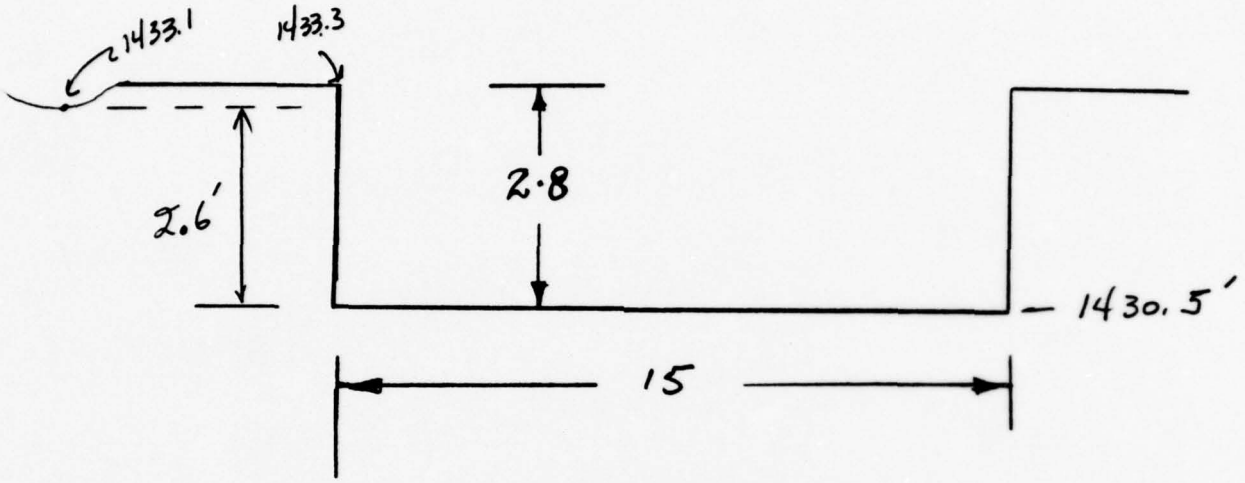
$$V_c = \left(64.4 \frac{y_c}{2}\right)^{1/2} \qquad Q_c = V_c \times A_c.$$

| H HEIGHT ABOVE SPILLWAY CREST (FT) | ELEVATION ABOVE M.S.L (FT) | $y_c$ (FT) | $V_c$ FT/SEC | $A_c$ SQ. FT | $Q_c$ CFS. |
|---|---|---|---|---|---|
| 0 | 1430.7 | 0 | 0 | 0 | 0 |
| 0.8 | 1431.5 | 0.53 | 4.13 | 25.97 | 107 |
| 1.8 | 1432.5 | 1.2 | 6.22 | 58.8 | 366 |
| 2.4 | 1433.1 | 1.60 | 7.18 | 78.40 | 563 |
| 2.8 | 1433.5 | 1.87 | 7.76 | 91.63 | 711 |
| 3.8 | 1434.5 | 2.53 | 9.03 | 123.97 | 1119 |
| 4.8 | 14355 | 3.2 | 10.15 | 156.8 | 1592 |
| 5.8 | 1436.5 | 3.87 | 11.16 | 189.63 | 2116 |
| 6.8 | 1437.5 | 4.53 | 12.07 | 224.97 | 2679 |

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 3
BY KHK DATE 10-17-78 PROJ. NO. 78-617-216
CHKD. BY RFV DATE 10-19-78 SHEET NO. 10 OF 15

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# CAPACITY OF RIGHT SPILLWAY.




SUPERCRITICAL FLOW IS ASSUMED AS THE SLOPE OF SPILLWAY CHANNEL IS GREATER THAN 5%

LET SPECIFIC HEAD $H_s = y + \frac{V^2}{2g}$ (REF 13, PG 139)

IN RESERVOIR, V, IS NEGLIGIBLE $\Rightarrow H_s = H = 2.6$ FT.

AT SPILLWAY INLET $H_s = y_c + \frac{V_c^2}{2g}$ (CRITICAL CONDITIONS)

$$\therefore y_c + \frac{V_c^2}{2g} = H$$

CRITICAL DEPTH $= \frac{V_c^2}{2g} = \frac{D_c}{2}$ (REF 13, PG. 143)

WHERE $D_c$ = HYDRAULIC DEPTH $= \frac{\text{AREA}}{\text{TOP WIDTH}} = \frac{A_c}{W_c}$

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 3
BY KHK DATE 10-17-78 PROJ. NO. 78-617-216
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$A_c = 15\, y_c$

$w_c = 15$

$$y_c + \frac{15\, y_c}{2 \times 15} = 2.6$$

$$1.5\, y_c = 2.6 \qquad y_c = 1.73$$

$$V_c^2/2g = \frac{D_c}{2} = \frac{15 \times 1.73}{2 \times 15} = 0.865$$

$$V_c^2 = 64.4 \times .865$$

$$V = 7.46 \text{ FT/SEC.}$$

$$Q = V_c \times A_c = 7.46 \times 15 \times 1.73 = 194 \text{ CFS}$$

CHECK SLOPE: (SEE SHEET 8)

$$S_c = \left(\frac{Q_c\, n}{1.49\, A_c R_c^{2/3}}\right)^2 \Rightarrow$$

$Q_c = 194$ CFS
$n = 0.014$ (REF 7, PG. 116)
$A_c = (15')(1.73') = 26.0 \text{ FT}^2$
$R_c = 26.0 \text{ FT}^2 / (15' + 1.73' + 1.73') = 1.41 \text{ FT}$

$$\therefore S_c = \left[\frac{(194)(0.014)}{1.49(26.0)(1.41)^{2/3}}\right]^2 = 0.31\% < 5\%$$

⇒ CRITICAL FLOW CONTROLS

MAXIMUM SPILLWAY CAPACITY = 194 CFS

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 3

BY KHK DATE 10-16-78 PROJ. NO. 78-617-216

CHKD. BY RFV DATE 10-19-78 SHEET NO. 12 OF 15

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## ELEVATION DISCHARGE RELATIONSHIP FOR RIGHT SPILLWAY

THE PROCEDURE USED TO CALCULATE THE SPILLWAY CAPACITY ON SHEETS 10 AND 11 WILL BE FOLLOWED TO DETERMINE THE DISCHARGE VALUES:

$$y_c = H/1.5$$

$$V_c = \left(64.4 \frac{y_c}{2}\right)^{1/2}$$

$$Q_c = V_c \times A_c$$

| H HEIGHT ABOVE SPILLWAY CREST FT. | ELEVATION ABOVE M.S.L FT | $y_c$ FT | $V_c$ FT/SEC | $A_c$ SQ FT. | $Q_c$ CFS. |
|---|---|---|---|---|---|
| 0 | 1430.5 | - | - | - | - |
| 1 | 1431.5 | 0.67 | 4.6 | 10.05 | 46 |
| 2 | 1432.5 | 1.33 | 6.5 | 19.95 | 130 |
| 2.6 | 1433.1 | 1.73 | 7.46 | 25.95 | 194 |
| 3 | 1433.5 | 2 | 8.02 | 30 | 241 |
| 4 | 1434.5 | 2.67 | 9.27 | 40.05 | 371 |
| 5 | 1435.5 | 3.33 | 10.35 | 49.95 | 517 |
| 6 | 1436.5 | 4 | 11.34 | 60 | 680 |
| 7 | 1437.5 | 4.67 | 12.26 | 70.05 | 859 |

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 3
BY KHH DATE 10-18-78 PROJ. NO. 78-617-216
CHKD. BY RFV DATE 10-19-78 SHEET NO. 13 OF 15

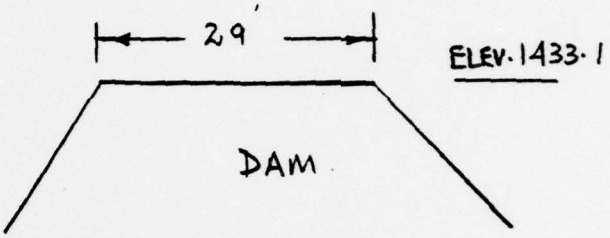
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## DISCHARGE DUE TO DAM OVERTOPPING.

AVE CREST WIDTH = 29'

CREST ELEVATION = 1433.1

CREST LENGTH = 400




$Q = CLH^{3/2}$

| ELEVATION | H (FT) | H/ℓ | C* | Q CFS |
|---|---|---|---|---|
| 1433.1 | 0 | – | – | – |
| 1433.5 | 0.4 | .014 | 3.00 | 304 |
| 1434.5 | 1.4 | .05 | 3.04 | 2,014 |
| 1435.5 | 2.4 | .08 | 3.05 | 4,536 |
| 1436.5 | 3.4 | .12 | 3.05 | 7,649 |
| 1437.5 | 4.4 | .15 | 3.05 | 11,260 |

* DISCHARGE COEFFICIENT BASED ON CRITERIA FOR EMBANKMENT SHAPED WEIRS - FIG 24 REF 12 (1970)

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 3

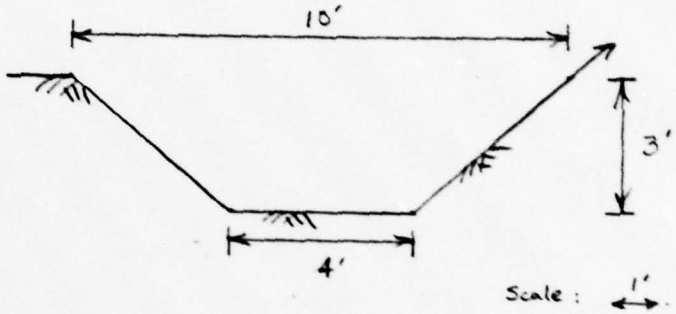
BY WJV DATE 11/29/78 PROJ. NO. 78-617-216

CHKD. BY DLB DATE 11/30/78 SHEET NO. 14 OF 15

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# RACEWAY ANALYSIS

TYPICAL CROSS SECTION :




RACEWAY CAPACITY = 126 CFS ("HUTCHINSON RESERVOIR Nº 3 DAM" PHASE I INSPECTION REPORT, NATIONAL DAM INSPECTION PROGRAM, BY GAI CONSULTANTS, INC FOR THE BALTIMORE DISTRICT CORPS OF ENGINEERS)

APPROXIMATE RACEWAY LENGTH = 1600 FT

APPROXIMATE RACEWAY STORAGE CAPACITY @ FULL FLOW :

STORAGE = AVERAGE SURFACE AREA × AVERAGE DEPTH

$$\text{STORAGE} = \left[(10' \times 1600') + (4' \times 1600')\right] \times \frac{3'}{2} = 33600 \text{ FT}^3$$
$$= 0.77 \text{ AC-FT}$$

RACEWAY STORAGE IS INSIGNIFICANT AND WILL BE NEGLECTED IN THE SPILLWAY ANALYSIS

ASSUME RACEWAY FLOWS FULL BY THE TIME THE RESERVOIR LEVEL RAISES 5 FT (FROM ELEV 1375.5 @ "0" RESERVOIR STORAGE TO ELEV 1380.5) ⇒ RACEWAY FLOWS FULL SHORTLY AFTER BEGINNING OF DIRECT RUNOFF GENERATION

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 3

BY KHK DATE 10-18-78 PROJ. NO. 28-617-216

CHKD. BY RFJ DATE 10-19-78 SHEET NO. 15 OF 15

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## COMBINED DISCHARGE RATING CURVE

| ELEVATION | RATING | RIGHT SPILLWAY CFS | LEFT SPILLWAY CFS | OVERTOPPING DAM CFS | COMBINED Q CFS. |
|---|---|---|---|---|---|
| 1430.5 | 0 | 0 | – | – | – |
| 1431.5 | 126 | 46 | 107 | – | 279 |
| 1432.5 | 126 | 130 | 366 | – | 622 |
| 1433.1 | 126 | 194 | 563 | 0 | 883 |
| 1433.5 | 126 | 241 | 711 | 304 | 1382 |
| 1434.5 | 126 | 371 | 1119 | 2,014 | 3630 |
| 1435.5 | 126 | 517 | 1592 | 4,536 | 6771 |
| 1436.5 | 126 | 680 | 2116 | 7,649 | 10571 |
| 1437.5 | 126 | 859 | 2679 | 11,260 | 14924 |

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº 1

BY DLB DATE 10-24-78 PROJ. NO. 78-617-214

CHKD. BY WJV DATE 1/9/79 SHEET NO. 1 OF 13

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DAM LOCATION - BROWNFIELD QUADRANGLE, FAYETTE COUNTY, PENNSYLVANIA; U.S.G.S. 7.5 MINUTE SERIES, (TOPOGRAPHIC) PHOTOREVISED 1973

## DAM STATISTICS

MAXIMUM HEIGHT - 33 FEET (FIELD MEASURED)

DRAINAGE AREA - 0.43 SQ. MI. (PLANIMETERED OFF U.S.G.S. BROWNFIELD QUADRANGLE)

STORAGE CAPACITY -

@ NORMAL POOL (EL 1291.8) ≃ 45 AC-FT (SEE NOTE BELOW)
@ TOP OF DAM (EL 1294.3) ≃ 56 AC-FT (SHEET 5)

## SIZE CLASSIFICATION

DAM SIZE - SMALL (REF 1; TABLE 1)

HAZARD RATING - HIGH (FIELD OBSERVATION: REF 1: TABLE 2)

REQUIRED SDF - ½ PMF TO PMF (REF 1; TABLE 3)

NOTE: THE VALUE OF STORAGE CAPACITY IS TAKEN FROM AN UNPUBLISHED NOTEBOOK CONTAINING PERTINANT DATA FOR DAMS OPERATED BY THE UNIONTOWN BRANCH OF W.P.W. THE NOTEBOOK IS AVAILABLE FROM THE FILES LOCATED AT THE UNIONTOWN OFFICE OF W.P.W..

SUBJECT DAM SAFETY INSPECTION.
HUTCHINSON RESERVOIR # 1

BY KHK DATE 10-11-78 PROJ. NO. 78-617-214

CHKD. BY RFV DATE 10-13-78 SHEET NO. 2 OF 13

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## HUTCHINSON RESERVOIR # 1

### DRAINAGE AREA:

LOCAL = 0.43 SQ. MILE

U.S.G.S MAP
BROWNFIELD QUAD.
PENNSYLVANIA

TOTAL = 1.9 + .09 + .43
= 2.42 SQ. MILES.

SURFACE AREA (NORMAL POOL) = 0.04 SQ. INC. (PLANIMETERED)
= 3.7 ACRES.

SURFACE AREA AT CONTOUR 1300 = 0.063 SQ IN (PLANIMETERED)
= 5.79 ACRES. = 5.8

SURFACE AREA AT CONTOUR 1320 = 0.13 SQ. IN (PLANIMETERED)
= 11.9 ACRES

RATE OF AREA CHANGE PER FOOT OF RISE:

$$\frac{\Delta A}{\Delta Y} = \frac{(11.9 \text{ ACRES}) - (3.7 \text{ ACRES})}{(1320 \text{ FEET}) - (1291.8 \text{ FEET})} = 0.29 \text{ ACRE/FT}$$

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR DAM Nº 1

BY DLB DATE 10-24-78 PROJ. NO. 78-617-214

CHKD. BY WJV DATE 11/28/78 SHEET NO. 3 OF 13

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## UNIT HYDROGRAPH PARAMETERS

LENGTH OF LONGEST WATERCOURSE (L) ≅ 1.17 MILES

$L_{CA}$ ≅ 0.56 MILES

[VALUES OF L AND $L_{CA}$ ARE FROM U.S.G.S. 7.5 MINUTE QUAD BROWNFIELD, PA.]

NOTE: ALL VARIABLES ARE DEFINED IN REFERENCE 2 IN THE SECTION ENTITLED "SNYDER SYNTHETIC UNIT HYDROGRAPH"

$C_t = 1.6$

$C_p = 0.5$

[SUPPLIED BY C of E; ZONE 29, OHIO RIVER BASIN]

$t_p$ = SNYDER'S STANDARD LAG = $1.6 (L \times L_{CA})^{0.3}$

$t_p = (1.6)[(1.17)(0.56)]^{0.3} = 1.41$ HRS

## PMP CALCULATIONS

HUTCHINSON RESERVOIR DAM Nº 1 LOCATION - ZONE 7 (REF 3)

PMP INDEX = 24 INCHES (FIG 1, REF 3)

DURATION % INDEX -

6 HRS = 102

12 HRS = 120

24 HRS = 130

NOTE: A 24-HOUR RATHER THAN A 49-HR TOTAL DURATION WAS USED. THIS WAS NECESSITATED BY THE NEED TO USE A 5-MINUTE TIME STEP IN THE HEC-1-DAM PROGRAM IN ORDER TO MORE ACCURATELY DEFINE THE PEAKS OF THE HYDROGRAPHS. (A MAXIMUM OF ONLY 300 TIME INTERVALS IS ALLOWED IN THE PROGRAM.)

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR # 1
BY KHK DATE 10-12-78 PROJ. NO. 78-617-214
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## APPROXIMATE ELEVATION @ ZERO STORAGE

VOLUME = $\frac{1}{3}$ HA (CONIC METHOD)

VOLUME = 45.4 ACRE-FT (SEE NOTE SHEET 1)

SURFACE AREA = 3.7 ACRES (PLANIMETERED)

$$H = \frac{3 \times 45.4}{3.7} = 36.8 \text{ FT.}$$

ELEVATION AT SPILLWAY CREST = 1291.8 FT (WPW. FILE UNION TOWN OFFICE)

ELEVATION AT ZERO VOLUME = 1291.8 − 36.8

= 1255. FT.

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR DAM Nº 1
BY DLB DATE 1/5/79 PROJ. NO. 28-617-214
CHKD. BY WJV DATE 1/9/79 SHEET NO. 5 OF 13

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## ACTUAL ESTIMATED ELEVATION - STORAGE RELATIONSHIA

ESTIMATED SURFACE AREA: (LINEAR INTERPOLATION EQUATION)

$$A = A_o + \left(\frac{\Delta A}{\Delta Y}\right) y$$

$A_o$ = 3.7 ACRES

$\frac{\Delta A}{\Delta Y}$ = 0.29 ACRE/FT

$y$ = (ELEVATION OF CONCERN) - 1291.8'

ESTIMATED INCREMENTAL INCREASE IN STORAGE:

MODIFIED PRISMOIDAL FORMULA (REF 14, pg 15): $\Delta V_{1-2} = \frac{Y}{3}\left(A_1 + A_2 + \sqrt{(A_1)(A_2)}\right)$

| ELEVATION (FT) | ESTIMATED AREA (ACRE) | CUMULATIVE INCREASE IN STORAGE ABOVE NORMAL POOL VIA MOD. PRIS. EQ. (ACRE-FEET) | AVAILABLE STORAGE BELOW NORMAL POOL (ACRE-FEET) | ACTUAL ESTIMATED STORAGE (ACRE-FEET) |
|---|---|---|---|---|
| 1291.8 | 3.7 | 0 | 45 | 45* |
| 1292.0 | 3.8 | 1 | " | 46 |
| 1293.0 | 4.0 | 5 | " | 50 |
| 1294.0 | 4.3 | 9 | " | 54 |
| 1294.3 | 4.4 | 11 | " | 56 |
| 1295.0 | 4.6 | 14 | " | 59 |
| 1296.0 | 4.9 | 19 | " | 64 |
| 1297.0 | 5.2 | 24 | " | 69 |
| 1298.0 | 5.5 | 29 | " | 74 |
| 1299.0 | 5.8 | 35 | " | 80 |
| 1300.0 | 6.1 | 40 | " | 85 |
| | | | " | |

* KNOWN VALUE (SEE NOTE SHEET 1)

EL 1291.8 - NORMAL POOL
EL 1294.3 - TOP OF DAM

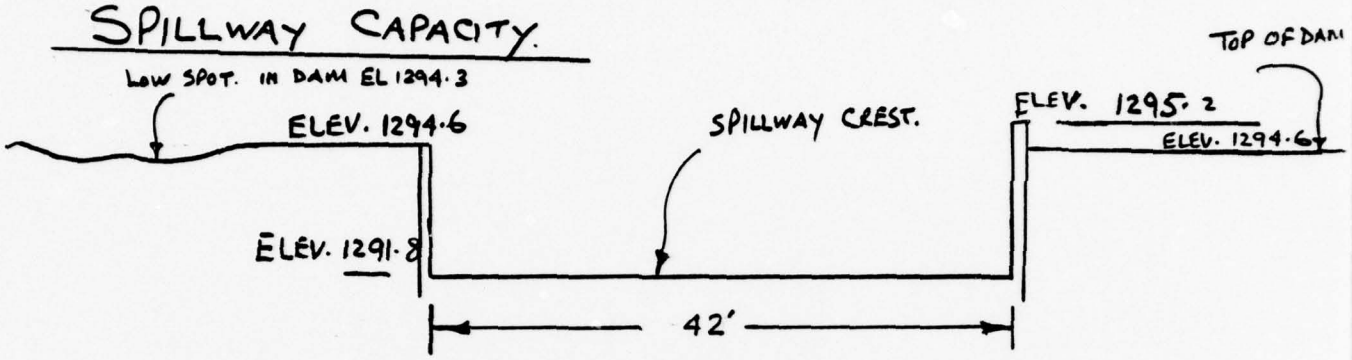
SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR # 1

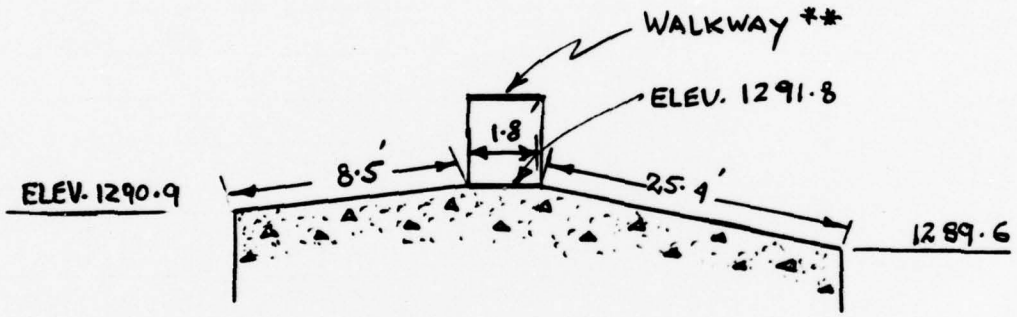
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CHKD. BY WJV DATE 1-13-79 SHEET NO. 6 OF 13

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# SPILLWAY CAPACITY




MAXIMUM HEAD = 1294.3 - 1291.8 = 2.5 FT.

LENGTH OF WEIR = 42 FT.

$Q = C L H^{3/2}$ (REF 5, EQ 5-10)

$= 3.07^{*} \times 42 \times (2.5)^{3/2}$ * C VALUE EXTRAPOLATED FROM TABLE 5-3 REF 5

$= 509.7$ CFS (SAY 510 CFS)

** WALKWAY ALLOWANCE NEGLECTED

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR # 1

BY DLB DATE 1/13/79 PROJ. NO. 78-617-214

CHKD. BY WJV DATE 1/13/79 SHEET NO. 7 OF 13

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# SPILLWAY RATING CURVE

$$Q = C^{*}LH^{3/2}$$

* C VALUE EXTRAPOLATED ** TOP OF DAM

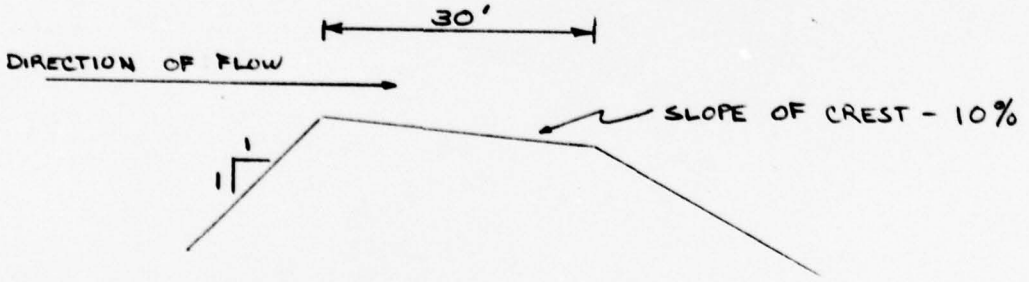
| ELEVATION FT. | H FT | $H^{3/2}$ | $C^{*}$ | Q CFS |
|---|---|---|---|---|
| 1291.8 | 0 | 0 | 0 | 0 |
| 1292 | 0.2 | .089 | 2.54 | 10 |
| 1292.5 | 0.7 | .586 | 2.61 | 64 |
| 1293 | 1.2 | 1.31 | 2.7 | 149 |
| 1293.5 | 1.7 | 2.22 | 2.88 | 268 |
| 1294 | 2.2 | 3.26 | 2.94 | 403 |
| 1294.3** | 2.5 | 3.95 | 3.07 | 510 |
| 1295 | 3.2 | 5.72 | 3.25 | 781 |
| 1295.5 | 3.7 | 7.12 | 3.32 | 992 |
| 1296 | 4.2 | 8.61 | 3.32 | 1200 |
| 1297 | 5.2 | 11.86 | 3.32 | 1653 |
| 1298 | 6.2 | 15.44 | 3.32 | 2153 |
| 1299 | 7.2 | 19.32 | 3.32 | 2694 |

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR DAM N° 1
BY DLB DATE 10-20-78 PROJ. NO. 78-617-214
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# MAIN DAM

THE TOP OF DAM IS AT ELEVATION 1294.3. THIS IS THE POINT WHERE OVERTOPPING OF THE DAM STARTS. THE TOTAL COMBINED LENGTH OF THE DAM, EXCLUDING THE SPILLWAY, IS 278 FT. THE BREADTH OF THE CREST OF THE DAM IS 30 FT AND IS ON A 10% SLOPE AS SHOWN BELOW.




$$Q = CLH^{3/2}$$

(REF 5, EQ 5-10)

BREATH OF CREST = 30 FT
LENGTH OF DAM = 278 FT

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR DAM Nº 1

BY RFV DATE 10-23-78 PROJ. NO. 78-617-214

CHKD. BY KMH DATE 10-24-78 SHEET NO. 9 OF 13

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# MAIN DAM RATING CURVE

$$Q = C^* L H^{3/2}$$

| ELEVATION | H (FT) | $H^{3/2}$ | H/B | C | Q (CFS) |
|---|---|---|---|---|---|
| 1294.3 | 0 | 0 | 0 | | 0 |
| 1295 | 0.7 | 0.586 | 0.023 | 3.03 | 493 |
| 1295.5 | 1.2 | 1.315 | 0.04 | 3.04 | 1111 |
| 1296 | 1.7 | 2.217 | 0.057 | 3.04 | 1873 |
| 1297 | 2.7 | 4.437 | 0.090 | 3.05 | 3762 |
| 1298 | 3.7 | 7.117 | 0.123 | 3.05 | 6035 |
| 1299 | 4.7 | 10.189 | 0.157 | 3.06 | 8668 |

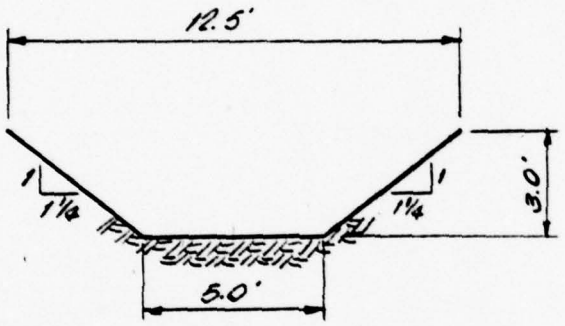
* VALUES OF "C" ARE TAKEN FROM REFERENCE 12, FIG. 24, pg 96

THE EFFECT OF THE 10% CREST SLOPE ON THE WEIR COEFFICIENTS IS NEGLIGIBLE IF THE CURVE OF REFERENCE 12 IS USED TO DETERMINE THE "C"'s (REF. 5 and 8).

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR #1 DAM
BY EJM DATE 10-30-78 PROJ. NO. 78-617-214
CHKD. BY DLB DATE 10-31-78 SHEET NO. 10 OF 13

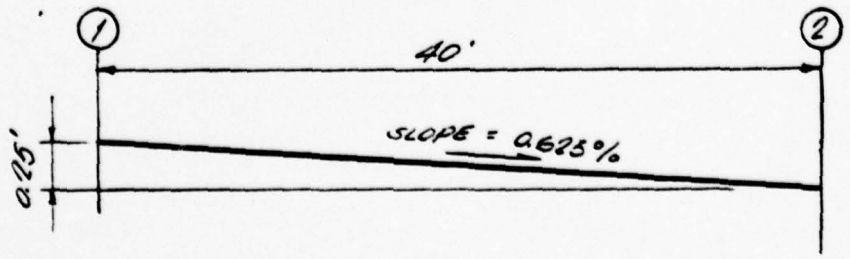
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## CALCULATION OF FLOW CAPACITY IN RACEWAY




NOTE: CHANNEL IS LINED WITH HIGH VEGETATION, ROCK DEBRIS, AND BRUSH. (FIELD OBSERVATION)

TYPICAL CROSS-SECTION THROUGH RACEWAY *
SCALE: 1" = 5'




PROFILE THROUGH RACEWAY *
SCALE: 1" = 10' H
1" = 1' V

* ALL DIMENSIONS REPRESENT FIELD MEASUREMENTS.

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR #1 DAM

BY EJM DATE 10-30-78 PROJ. NO. 78-617-214

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THE FOLLOWING SIMPLIFYING ASSUMPTIONS ARE IN APPROXIMATING THE FLOW CAPACITY OF THE RACEWAY:

1. THE LINING AS DESCRIBED BY THE NOTE ON SHEET 10 IS CONSISTENT OVER THE ENTIRE CHANNEL LENGTH, THEREFORE THE ROUGHNESS COEFFICIENT IS UNIFORM.

2. THE SIDE SLOPES OF THE RACEWAY ARE CONSTANT OVER THE CHANNEL LENGTH.

3. THE CHANNEL SLOPE IS CONSTANT AT 0.625%

4. FLOW IS TURBULENT AND THE MANNING EQUATION APPLIES.

MANNING EQUATION:

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$ (REF 7, EQ 5-6, PG 99)

WHERE: Q - QUANTITY OF FLOW (CFS)
n - ROUGHNESS COEFFICIENT
A - AREA OF FLOW ($FT^2$)
R - HYDRAULIC RADIUS (FT) = $\frac{A}{WP}$
S - SLOPE (FT/FT)
WP - WETTED PERIMETER

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR DAM Nº 1

BY DLB DATE 10-30-78 PROJ. NO. 78-617-214

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- QUANTITY OF FLOW FOR d = 3.0

$$A = 2(\tfrac{1}{2})(3.75')(3.0') + (5.0')(3.0')$$
$$= 26.25\ FT^2$$

$$WP = 4.8' + 5.0' + 4.8'$$
$$= 14.6\ FT$$

$$R = 26.25\ FT^2 / 14.6\ FT$$
$$= 1.80\ FT$$

$$S = 0.00625 \simeq 0.006$$

$$n = 0.040 \qquad \text{(REF 2, pg 112)}$$

$$Q = \frac{1.49}{0.040}(26.25)(1.80)^{2/3}(0.006)^{1/2}$$

$$Q = 112.1\ CFS$$

- APPROXIMATE STORAGE CAPACITY @ FULL FLOW

RACEWAY LENGTH ≈ 800 FT.

STORAGE = AVERAGE SURFACE AREA × AVERAGE DEPTH
$= [(12.5' \times 800') + (5.0' \times 800')] \times \frac{3'}{2} = 21000\ FT^3 = 0.48\ A\text{-}F$

∴ RACEWAY STORAGE IS INSIGNIFICANT AND WILL BE NEGLECTED

ASSUME RACEWAY FLOWS FULL BY THE TIME THE RESERVOIR WATER LEVEL RAISES 0.7 FT, DUE TO THE COMBINATION OF DIRECT DRAINAGE OF THE SUBAREA'S LONGEST WATERCOURSE AND THE CONTRIBUTIONS OF THE US RESERVOIR

SUBJECT DAM SAFETY INSPECTION
HUTCHINSON RESERVOIR Nº1

BY DLB DATE 1/13/79 PROJ. NO. 78-617-214

CHKD. BY WJV DATE 1/13/79 SHEET NO. 13 OF 13

gai CONSULTANTS.
Engineers • Geologists • Planners
Environmental Specialists

## TOTAL DAM RATING CURVE (SPILLWAY + MAIN DAM + RACEWAY)

| ELEVATION | Q SPILLWAY | Q OVERTOPPING OF DAM | Q RACEWAY | Q (CFS) COMBINED |
|---|---|---|---|---|
| 1291.8 | 0 | 0 | 0 | 0 |
| 1292 | 10 | 0 | 0 | 10 |
| 1292.5 | 64 | 0 | 112 | 176 |
| 1293 | 149 | 0 | 112 | 261 |
| 1293.5 | 268 | 0 | 112 | 380 |
| 1294 | 403 | 0 | 112 | 515 |
| 1294.3 | 510 | 0 | 112 | 622 |
| 1295 | 781 | 493 | 112 | 1386 |
| 1295.5 | 992 | 1111 | 112 | 2215 |
| 1296 | 1200 | 1873 | 112 | 3185 |
| 1297 | 1653 | 3762 | 112 | 5527 |
| 1298 | 2153 | 6035 | 112 | 8300 |
| 1299 | 2694 | 8668 | 112 | 11474 |

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# APPENDIX D

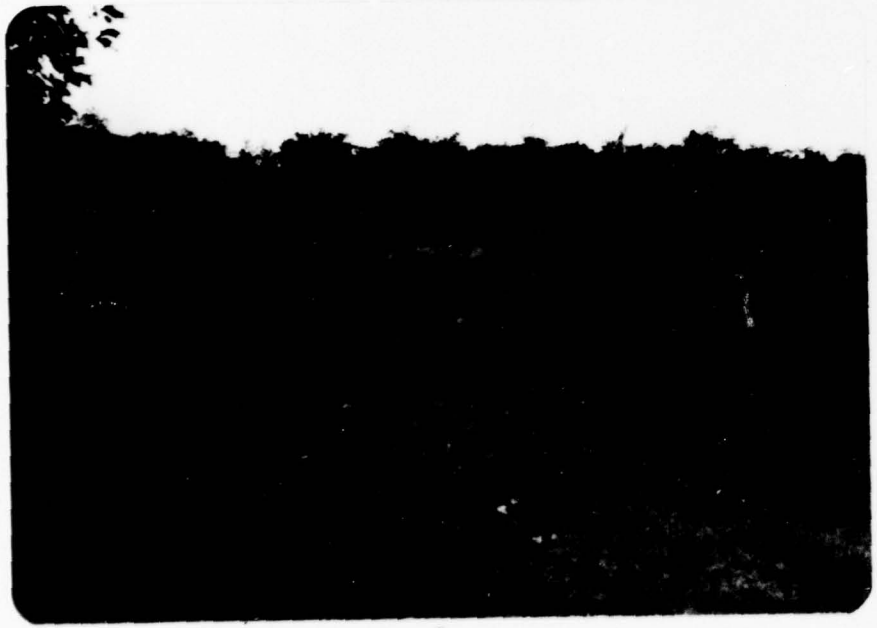
# PHOTOGRAPHS



1



2



3



4

PHOTOGRAPH 5 View of the masonry wall (saddle dam) adjacent to the left abutment.

PHOTOGRAPH 6 Close-up view of the upstream face of Dam No. 2. Note the slump features near the center of the photograph.

PHOTOGRAPH 7 Close-up view of clay plug (note apparent hole) just upstream of the spillway.

PHOTOGRAPH 8 View of the valley downstream of Dam No. 2 as seen from the crest, just to the right of the spillway.



5



6



7



8

PHOTOGRAPH 9 Close-up view of the tiered spillway at Dam No. 2.

PHOTOGRAPH 10 View of the spillway outlet channel from a point approximately 150 feet downstream of the spillway crest.

PHOTOGRAPH 11 View of the rock ledge over which the spillway discharge is conveyed before entering the natural downstream drainage.

PHOTOGRAPH 12 Disturbed area in downstream rock facing where apparent grouting was undertaken.



9



10



11



12

PHOTOGRAPH 13 View of the gate controls on the blowoff line (foreground) and supply line (background) located at the toe of the embankment.

PHOTOGRAPH 14 View of a small pond located between Hutchinson Reservoirs Nos. 2 and 1. Using a system of pipes and flashboards, the owner can either direct water into Reservoir No. 2, via the channel in the foreground, or install flashboards in the foreground channel and divert water throughout the diversion ditch which passes around Reservoir No. 2.



13



14

# APPENDIX E

# GEOLOGY

GEOLOGY

Hutchinson Reservoir Dams Nos. 1, 2 and 3 are located approximately 3 miles southeast of Uniontown on the western edge of the Allegheny Mountains section of the Appalachian Plateaus Province. The Allegheny Mountain section is characterized by gently folded sedimentary rock strata of Pennsylvanian age or older. Major structural axes strike from southwest to northeast with flanking strata dipping northwest and southeast.

Structurally, the dams and reservoirs lie immediately west of the Chestnut Ridge anticline. The bedrock flanking the west side of Chestnut Ridge consist of Devonian and Mississippian age strata in the higher elevations of the watershed and Pennsylvanian age strata in the vicinity of the reservoirs and below. Near the dams the sedimentary rock strata dip to the northwest at approximately 1,800 feet per mile or 19 degrees.

Two widely spaced joint systems at right angles to each other commonly control drainage patterns on the flanks of Pennsylvania's ridges. In the vicinity of the site, the joint system striking N60°W is at right angles to the anticlinal axis and tends to align drainage patterns off the ridge in this direction. A secondary joint system parallels the anticlinal axis striking N30°E. The secondary system generally has a lesser influence on controlling drainage patterns. Redstone Creek, however, is strongly controlled

by both joint systems. The stream channel both above and below the Hutchinson reservoirs follows the primary N60°W bearing, whereas the section of Redstone Creek containing the reservoirs follows the secondary N30°E bearing (see Regional Vicinity Map, Appendix G). This abrupt directional change in the flow of Redstone Creek is not common in this section of Chestnut Ridge. Furthermore, a small fault, located about one mile northeast of the reservoirs is also known to strike along this same N30°E bearing. A strong structural influence is evidently controlling the direction of drainage along the section of Redstone Creek containing the Hutchinson reservoirs. Jointing and possibly faulting may be responsible for this drainage control. The influence this feature may have, if any, on the Hutchinson reservoirs is unknown, although it may have some bearing on seepage losses through the foundation of the reservoirs.

The strata underlying the alluvial and residual soils of the valley are members of the Allegheny Formation which is of lower Pennsylvanian age. The group consists of shale and sandstone with lesser amounts of coal, clay, and limestone. The base is at the top of the Homewood sandstone and the top at the Upper Freeport coal seam which passes between Reservoir No. 2 and the upstream Reservoir No. 3. The Allegheny Formation is approximately 150 to 160 feet thick in the vicinity of the reservoirs.

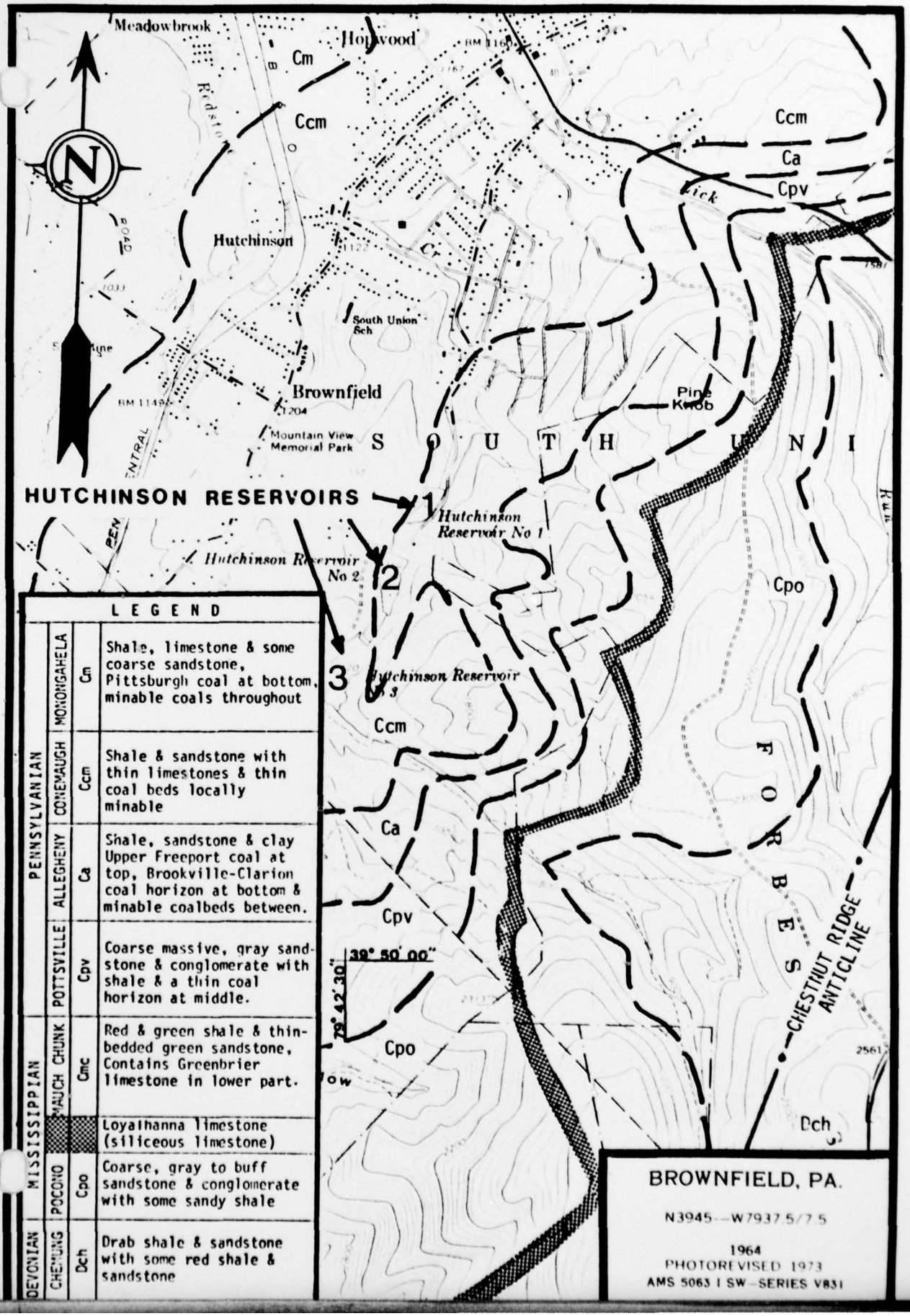
The Upper Freeport coal seam occurs above Reservoirs No. 1 and 2 along the west valley wall. The coal in this area is considered to average about four feet thick with several thick clay and shale partings. The coal is generally of good thickness and quality, but has not been prospected to any great extent. At the time of the inspection, there was no evidence of mining in the immediate area.

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Meadowbrook
Hollywood
Cm
Ccm
Ca
Cpv
Hutchinson
South Union Sch
Brownfield
Pine Knob
Mountain View Memorial Park
S O U T H U N I
HUTCHINSON RESERVOIRS
1
Hutchinson Reservoir No 1
2
Hutchinson Reservoir No 2
3
Hutchinson Reservoir No 3
Cpo
Ccm
Ca
Cpv
Cpo
39° 50' 00"
79° 42' 30"
F O R B E S
CHESTNUT RIDGE ANTICLINE
Dch
2561
LEGEND
PENNSYLVANIAN
MISSISSIPPIAN
DEVONIAN
MONONGAHELA Cm — Shale, limestone & some coarse sandstone, Pittsburgh coal at bottom, minable coals throughout
CONEMAUGH Ccm — Shale & sandstone with thin limestones & thin coal beds locally minable
ALLEGHENY Ca — Shale, sandstone & clay Upper Freeport coal at top, Brookville-Clarion coal horizon at bottom & minable coalbeds between.
POTTSVILLE Cpv — Coarse massive, gray sandstone & conglomerate with shale & a thin coal horizon at middle.
MAUCH CHUNK Cmc — Red & green shale & thin-bedded green sandstone, Contains Greenbrier limestone in lower part.
Loyalhanna limestone (siliceous limestone)
POCONO Cpo — Coarse, gray to buff sandstone & conglomerate with some sandy shale
CHEMUNG Dch — Drab shale & sandstone with some red shale & sandstone
BROWNFIELD, PA.
N3945—W7937.5/7.5
1964
PHOTOREVISED 1973
AMS 5063 I SW—SERIES V831

# APPENDIX F

# FIGURES

LIST OF FIGURES


| Figure | Description/Title |
|---|---|
| 1 | Plan (field sketch) |
| 2 | Cross Section (based on field measurements) |
| 3 | 1914 Plan and Profile |
| 4 | Alignment and Cross Section (June 1915) |

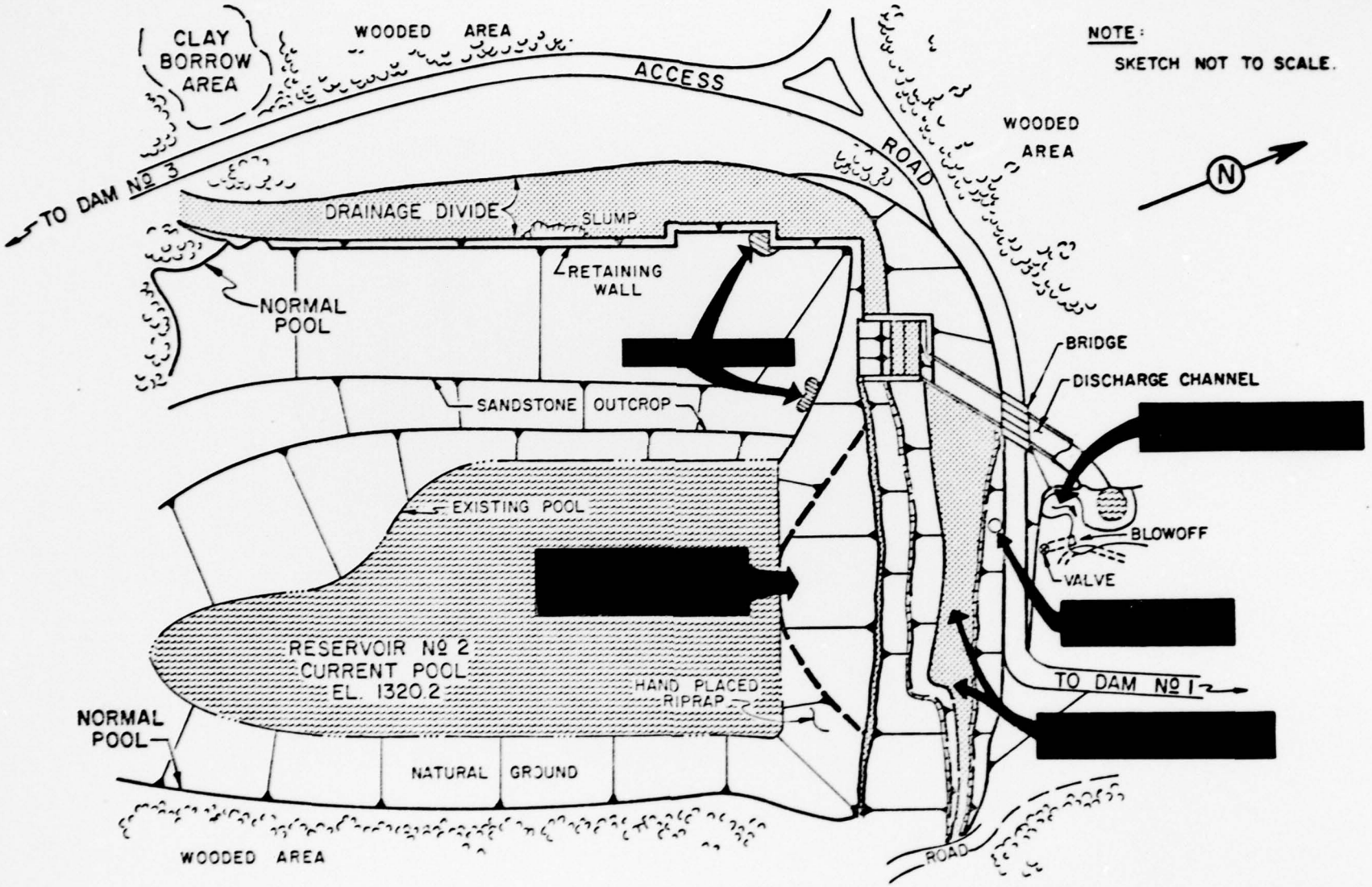
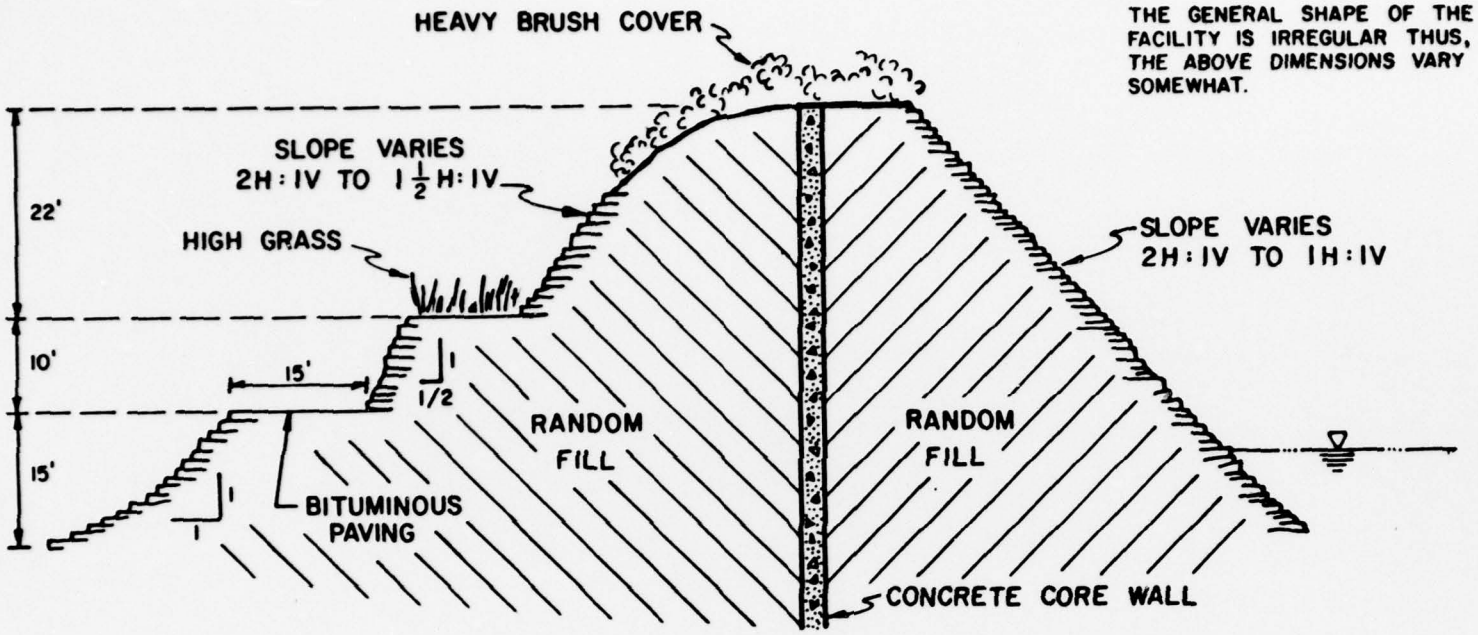
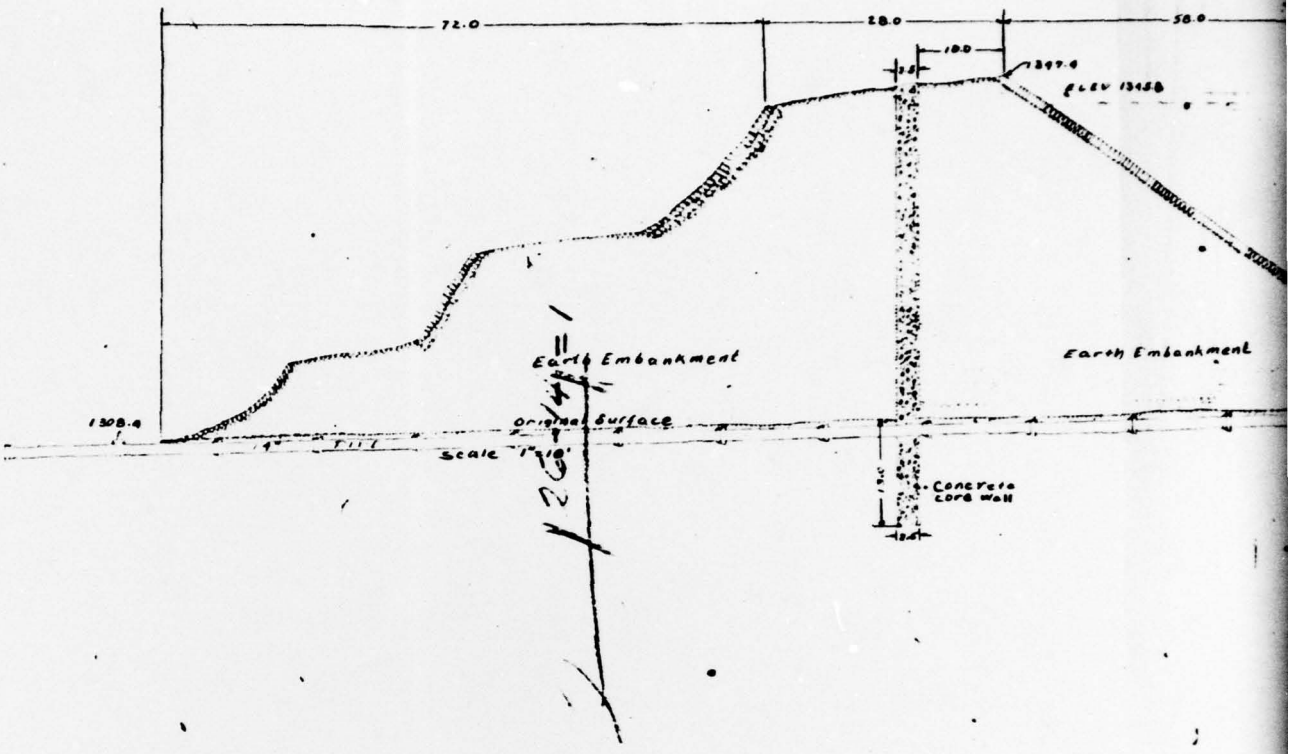


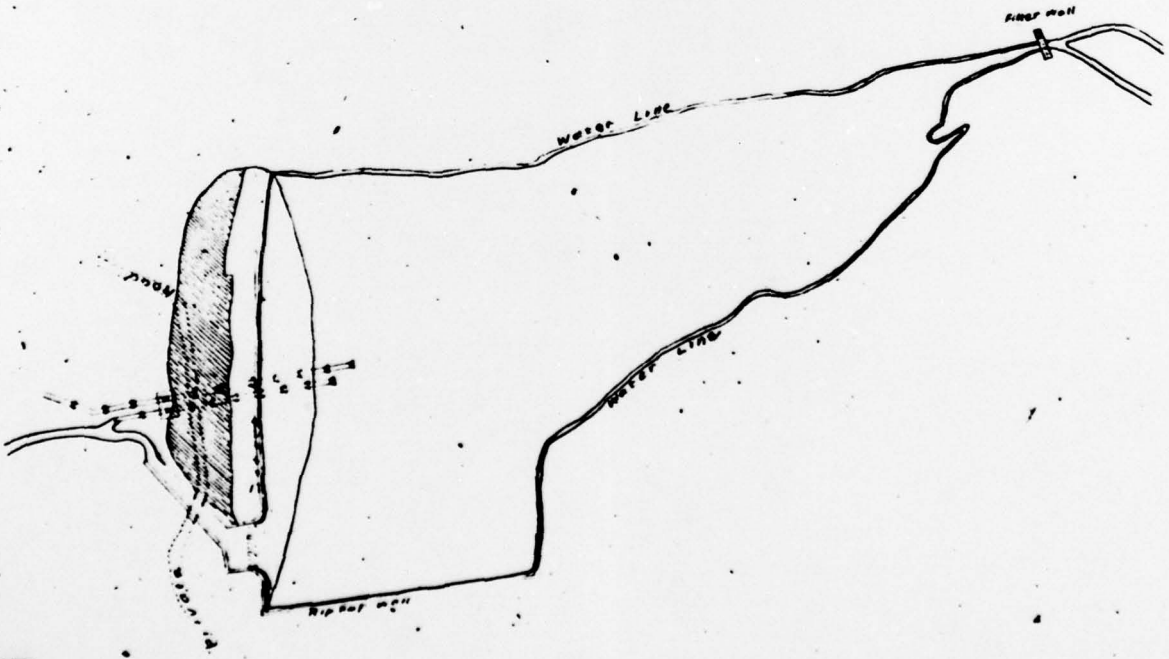

FIGURE 1 - HUTCHINSON RESERVOIR DAM Nº 2
GENERAL PLAN • FIELD INSPECTION NOTES



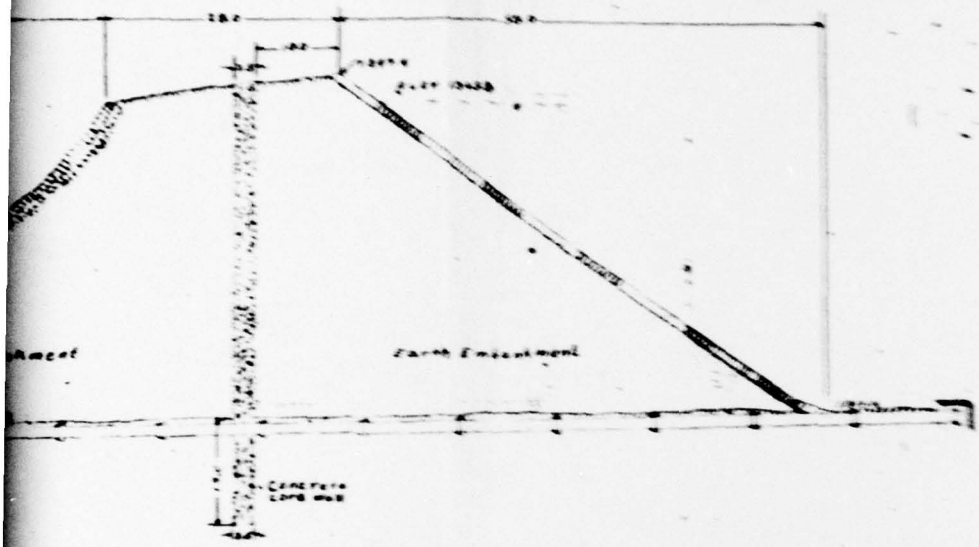

SLOPES ARE CONSTRUCTED OF HAND PLACED RIPRAP AS INDICATED.

FIGURE 2 - TYPICAL CROSS SECTION




UNIC
HUTC
SOU
FAY



UNIONTOWN WATER CO.

HUTCHISON RESERVOIR N° 2.

SOUTH-UNION TOWNSHIP.

FAYETTE COUNTY, PA.

2

FIGURE 3

SCALE 1 IN. = 20 FT.

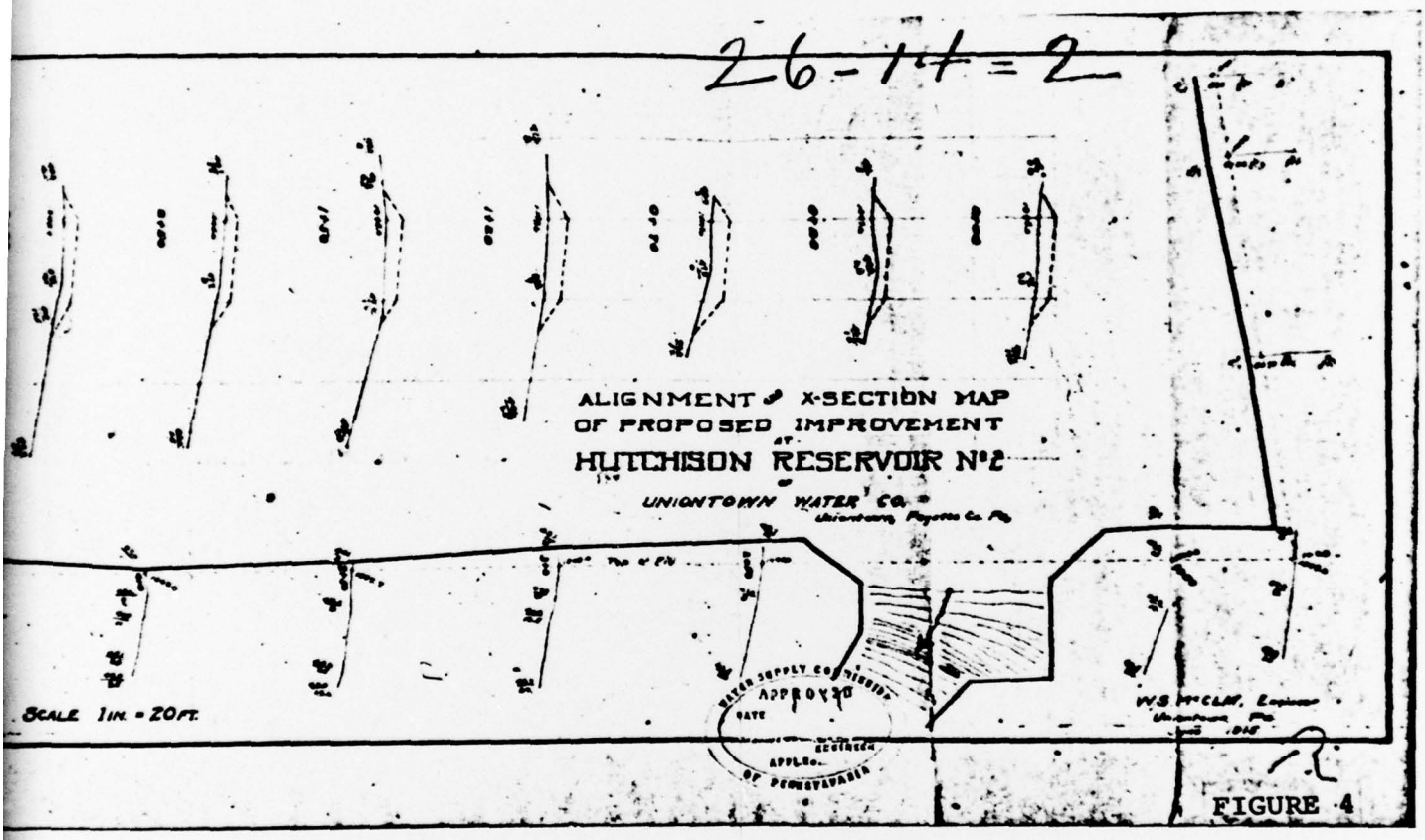
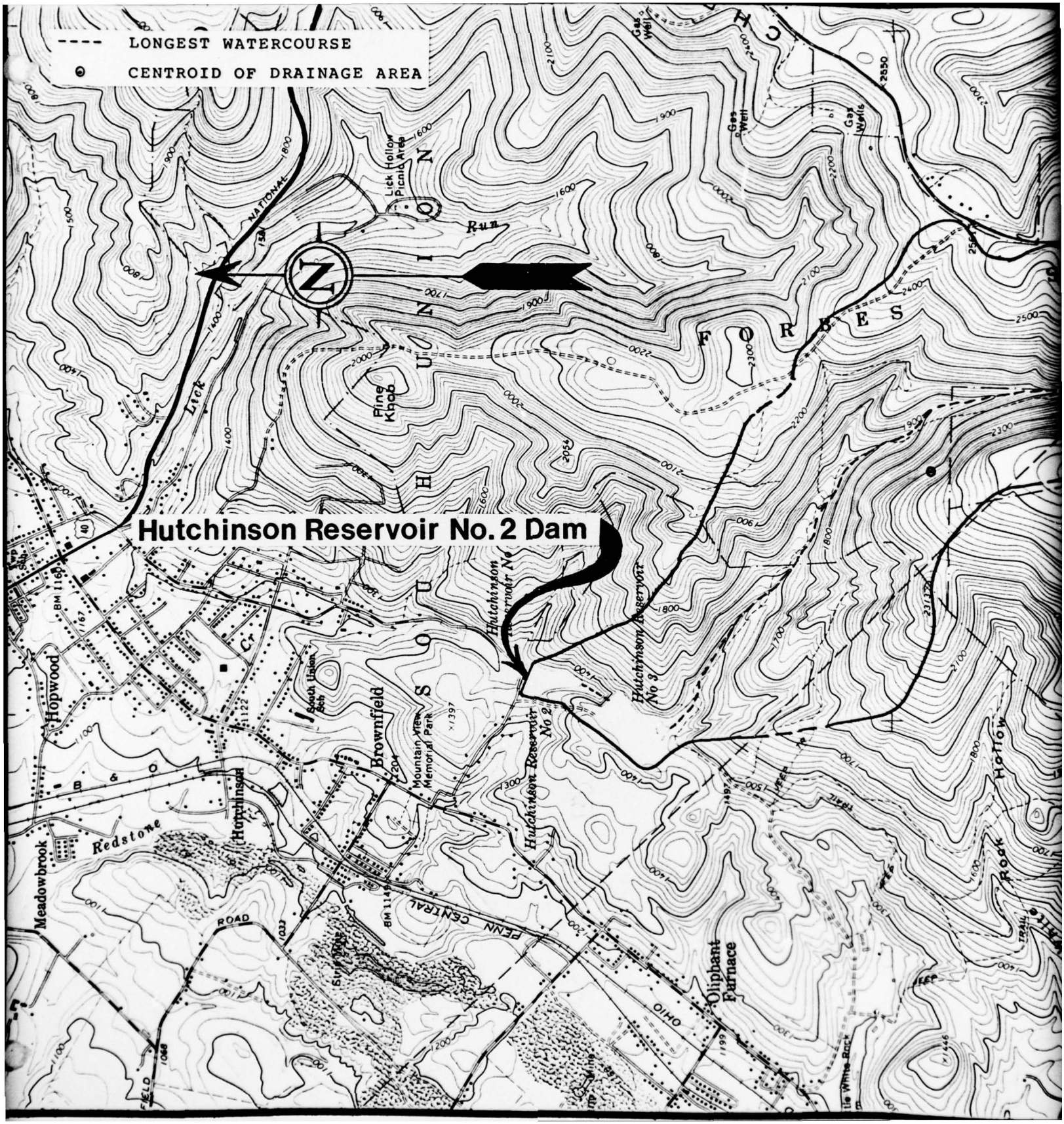

26-14=2
ALIGNMENT & X-SECTION MAP
OF PROPOSED IMPROVEMENT
AT
HUTCHISON RESERVOIR No 2
UNIONTOWN WATER CO.
SCALE 1 IN. = 20 FT.
APPROVED
W.S. McCLAY, Engineer

FIGURE 4

2

# APPENDIX G

# REGIONAL VICINITY MAP


LONGEST WATERCOURSE
CENTROID OF DRAINAGE AREA
N
Hutchinson Reservoir No. 2 Dam
Lick Run
Fine Knob
Lick Hollow Picnic Area
Hutchinson Reservoir No. 3
Hutchinson Reservoir No. 2
Mountain View Memorial Park
Brownfield
Hopwood
Redstone
Meadowbrook
Oliphant Furnace
Rock Hollow
NATIONAL
PENN CENTRAL
OHIO
ROAD
FIELD
B & O
Gas Well
FOREST

BROWNFIELD, PA.
N3945--W7937.5/7.5
1964
PHOTOREVISED 1973
AMS 5063 I SW-SERIES V831
STATE GAME LANDS NO 138
STATE FOREST
Radio Tower
Point Breeze
Laurel Caverns
Gas Wells
Gas Well
BM 2712
2629
2610
White Rock Trail
Askoff
Hollow