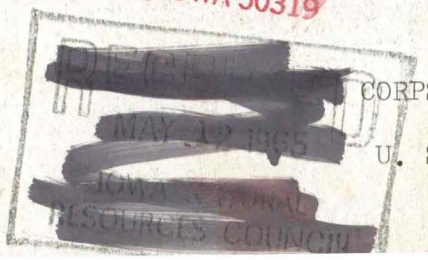
SKUNK RIVER, IOWA - AMES DAM AND RESERVOIR

DEPARTMENT OF THE ARMY



CORPS OF ENGINEERS
U. S. ARMY

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20315

IN REPLY REFER TO

ENGCW-PD

SUBJECT: Skunk River, Iowa - Ames Dam and Reservoir

TO: THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress the report of the Board of Engineers for Rivers and Harbors, accompanied by the reports of the District and Division Engineers, in partial response to a resolution by the Committee on Flood Control, House of Representatives, adopted 18 December 1945, and another by the Committee on Public Works of the United States Senate, adopted 1 June 1948, requesting the Board to review the report on Skunk River, Iowa, printed as House Document Numbered 170, Seventy-second Congress, first session, and subsequent reports on Skunk River, Iowa, with a view to determining the advisability of undertaking improvements for flood control and major drainage in the Skunk River basin at this time. The report is limited to consideration of a dam and reservoir at the Ames site on Skunk River concurrently with the contemplated construction in the near future of United States Interstate Highway No. 35, which has been planned to traverse the reservoir area. A final report in response to the resolutions will be submitted later.

2. The District and Division Engineers find that a dam and reservoir at the Ames site on Skunk River about 5 miles upstream from Ames, Iowa, is needed for the purposes of flood control, water quality control, recreation, fish and wildlife enhancement related to recreation, and future water supply, as a part of a basin plan to be formulated in the final report. They further find that a savings estimated at $1,682,000 can be made by initially constructing Interstate Highway No. 35 to a level sufficiently high for reservoir operation needs, in lieu of raising the highway after it is constructed at a lower level. They estimate the cost of construction, including initial raising of the highway, at $10,130,000. The annual charges are estimated at $416,800, including $48,000 for operation,

5-14-69 Gov. Off. Dgc

maintenance, and major replacements, and the annual benefits at $726,300. The benefit-cost ratio is 1.7. They recommend construction of the dam and reservoir, early coordination with the Bureau of Public Roads in adjusting Interstate Highway No. 35 to the reservoir needs, and additional studies of fish and wildlife resources after the project is authorized.

3. Upon review of the report of the District and Division Engineers, the Board of Engineers for Rivers and Harbors noted that greater safety and flexibility of use of the improvements by the public could be accomplished by rerouting Interstate Highway No. 35 to a reservoir-perimeter location, in lieu of the proposed location along the 3-mile crossing through the reservoir. The Bureau of Public Roads, Department of Commerce, concurred in this view and has initiated studies for rerouting the highway east of the reservoir. Noting the need for additional flood-control storage at the site, the need for additional leakage-prevention measures under the dam, and necessary adjustments to farm-tile drain systems in the reservoir area, the Board obtained revised costs and benefits for these provisions from the reporting officers. Flood-control storage would be increased from 3.6 inches of runoff to about 5.2 inches. As revised, the cost of construction is estimated at $12,893,000, the annual charges at $566,000, and the annual benefits at $896,000. The benefit-cost ratio is 1.6. In recognition of House of Representatives Bill Numbered 5269, Eighty-ninth Congress, first session, cited as the "Federal Water Project Recreation Act", the Board has estimated the separable initial costs of lands and facilities for recreation and fish and wildlife enhancement related to recreation at $600,000, of which non-Federal interests would be required to bear $300,000, and an additional $10,000 annually as upkeep therefor, with provision for more or less participation as permitted in the proposed Act. The Board concurs in the views of the reporting officers that when the water-supply purpose is needed, responsible authorities must agree to contribute for such storage in accordance with the policy for cost sharing applicable at that time. It is of the belief that responsible local interests should be required to hold and save the United States free from damages resulting from water-rights claims due to construction and operation of the reservoir for water conservation purposes; and that they should be required to exercise, to the full extent of their legal capability, control against removal of

5-14-69 G

streamflow made available for water quality control. The Board recommends authorization for construction and operation of the dam and reservoir essentially as planned by the District Engineer as subsequently modified, subject to the requirements of local cooperation called for in the proposed Federal Water Project Recreation Act cited above, plus those added by the Board and stated in the foregoing. It further recommends that, following authorization of the Ames Dam and Reservoir, detailed site investigations and design be made for the purpose of accurately defining the project lands required; and that subsequently, advance acquisition be made of such title to such lands as may be required to preserve the site against incompatible development; and that the Chief of Engineers be authorized to participate in the construction or reconstruction of transportation and utility facilities, particularly Interstate Highway No. 35 and adjuncts, in advance of project construction as required to preserve such areas from encroachment and avoid increased cost for relocations.

4. I concur in the views and recommendations of the Board.

W. K. WILSON, JR.
Lieutenant General, USA
Chief of Engineers

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
BOARD OF ENGINEERS FOR RIVERS AND HARBORS
WASHINGTON, D.C. 20315

IN REPLY REFER TO

ENGBR 21 April 1965

SUBJECT: Skunk River, Iowa - Ames Dam and Reservoir

TO: Chief of Engineers
Department of the Army

1. Authority and scope.--This interim report is in partial response to the following resolutions adopted 18 December 1945 and 1 June 1948, respectively:

> Resolved by the Committee on Flood Control, House of Representatives, That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act approved June 13, 1902, be and is hereby requested to review the report on the Skunk River, Iowa, printed as House Document No. 170, 72nd Congress, 1st Session, with a view to determining the advisability of undertaking improvements for flood control in the Skunk River at this time.

> Resolved by the Committee on Public Works of the United States Senate, That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the report on the Skunk River, Iowa, printed as House Document Numbered 170, Seventy-second Congress, First Session, and subsequent reports on the Skunk River, Iowa, with a view to determining the advisability of undertaking improvement for flood control and major drainage in the Skunk River Basin at this time.

ENGBR
SUBJECT: Skunk River, Iowa - Ames Dam and Reservoir

The report is limited to consideration of a dam and reservoir at the Ames site on the Skunk River concurrently with the contemplated construction in the near future of United States Interstate Highway No. 35, which has been planned to traverse the reservoir area. A final report in response to the resolutions will be submitted later.

2. Basin description.--The Skunk River basin covers an area of 4,355 square miles. The river has its source in north-central Iowa and discharges into the Mississippi River in the southeastern part of the state, 396 miles above the mouth of the Ohio River. The basin is about 180 miles long and averages about 24 miles in width. The watershed is in a glaciated region, the topography varying from quite flat to gently rolling.

3. Economic development.--The economy of the region of which the basin is a part is based on agriculture. Manufacturing in the centers of population is generally related to the needs of farmers or to processing of agricultural products. The largest city in the basin is Ames, Iowa, with a population of 27,000 in 1960. About one-third of the population in the basin is classed as rural.

4. Existing improvements.--There are no Corps of Engineers projects in the basin relating strictly to the Skunk River. Levees of the Green Bay Levee and Drainage District No. 2, located on the Mississippi River flood plain adjacent to the Skunk River, have been improved under authority of the Flood Control Acts of 1936 and 1954. Some 90 miles of the Skunk River and 24 miles of the North Skunk River have been straightened by local interests. Levees have also been constructed at various locations by local interests, particularly in Polk County.

5. Floods and flood damage.--Flooding on the Skunk River has occurred at frequent intervals and has resulted in extensive damage to crops and, to a lesser extent, rural property. About 95 percent of the average annual flood damage is sustained by agricultural interests. The most severe flood occurred in May 1944 and resulted in damages of more than 4.4 million dollars.

ENGBR
SUBJECT: Skunk River, Iowa - Ames Dam and Reservoir

Average annual damages in the Skunk River basin, exclusive of the North Skunk River, are estimated at $1,357,500.

6. Improvement desired.--A public hearing was held at Newton, Iowa, on 27 February 1964, attended by 443 persons. Oral and written statements reflecting diverse opinions regarding the proposed Ames Reservoir were received. A representative of the Bureau of Public Roads stated that delay in construction of Interstate Highway No. 35 would disrupt the schedule for completion of the national system of Interstate and Defense Highways.

7. Water uses considered.--The investigation considered flood problems, municipal and industrial water supply needs, water quality control, irrigation, recreation, hydroelectric power, and fish and wildlife. The Public Health Service, United States Department of Health, Education, and Welfare, estimates that the city of Ames will not have need for water supply from the reservoir until about the year 2020. The District Engineer estimates that the initial storage of 25,000 acre-feet required for water quality control can be used jointly for water supply by the time the latter is needed.

8. Plan of improvement.--The District Engineer finds that construction of a dam and reservoir on the Skunk River about 5 miles above Ames, Iowa, is economically justified. The project would result in benefits to flood control, water quality control, water supply, recreation, and fish and wildlife. Since the need for municipal and industrial water supply is many years in the future, the District Engineer concludes that cost sharing for that purpose should be in accordance with the policy in effect at that time.

9. Dam and reservoir.--The dam for Ames Reservoir would consist of an earth embankment about 75 feet high and about 1,260 feet long at the crest. Outlet works would be a gated single conduit. The spillway would be controlled by five tainter gates. The reservoir would cover about 4,350 acres at full pool, and would extend approximately 8 miles above the dam, being within banks at Story City, Iowa. Remedial work would consist of raising three

roads that cross the area, making a fourth road submersible, and relocating certain telephone and powerlines. Minor work would be required at Story City's sewage treatment plant.

10. Interstate Highway No. 35.--This highway is planned to traverse the reservoir area for a distance of about 3 miles. Design is complete, and acquisition of rights-of-way are partially complete for this reach and for reaches adjacent to the reservoir. Construction is scheduled to begin in 1965 and be complete in 1966. The incremental cost of building the reach of highway through the reservoir to conform to reservoir plans is estimated at $1,294,000. If the highway is built as presently planned, the cost of raising it at some future time to permit construction and operation of the reservoir is estimated at $2,815,000. Thus, a saving of $1,521,000 is indicated if the reservoir is to be constructed and if the highway is to be built initially to fit the reservoir needs. The original Iowa Highway Department cost estimate for passing two local roads across the Interstate, $161,000, is not included in these figures. Therefore, the total saving is $1,682,000.

11. Economic evaluation.--The cost of construction of Ames Reservoir, assuming that Interstate Highway No. 35 will be built to conform to reservoir needs, is estimated by the District Engineer at $10,130,000 on the basis of November 1964 prices. Since the benefits would be general in nature, the entire cost would be borne by the United States. The annual charges are estimated at $416,820, including $48,000 for operation, maintenance, and major replacements. Benefits are estimated at $726,300. On the basis of a 100-year period of analysis, the benefit-cost ratio is 1.7.

12. Recommendations of reporting officers.--The District Engineer recommends that construction of the Ames Reservoir be authorized substantially as described in his report, with such modifications thereof as in the discretion of the Chief of Engineers may be advisable, and that storage be developed for flood control, water quality control, water supply, recreation, and fish and wildlife benefits at an estimated first cost of $10,130,000 and an estimated annual cost of $48,000 for operation, maintenance, and

major replacements. He further recommends early coordination with the Bureau of Public Roads so that Interstate Highway No. 35 through the Ames Reservoir area can be built at a sufficiently high level to meet reservoir operation requirements and so that two local roads over the raised Interstate Highway No. 35 may be adjusted at the time of construction of the highway, thus obviating interruption of traffic on the highway after its completion. He also recommends that additional detailed studies of fish and wildlife resources be conducted after the project is authorized. The Division Engineer concurs.

13. Public notice.--The Division Engineer issued a public notice stating his recommendations and affording interested parties an opportunity to present additional information to the Board. Careful consideration has been given to the communications received.

Views and Recommendations of the Board of Engineers for Rivers and Harbors.

14. Views.--Upon review of the report of the District and Division Engineers, the Board noted that greater safety and flexibility of use of the improvements by the public, as well as savings in cost, could be accomplished by rerouting Interstate Highway No. 35 to a reservoir-perimeter location in lieu of the proposed location through the reservoir. The Bureau of Public Roads, Department of Commerce, concurred in this view and has initiated studies for rerouting the highway.

15. The Board further notes that plans for flood-control storage, as limited predominately by the cost of raising Interstate Highway No. 35, provide for only 3.6 inches of runoff. Considering that the maximum release from the reservoir would be limited to 1,000 cubic feet per second to conform to downstream channel requirements, the Board concluded that additional flood-control storage would be desirable. Considering removal of Interstate Highway No. 35 as a limiting factor, the reporting officers were requested to furnish information, including costs, for raising the flood-control pool to an optimum level. The information furnished indicates that as much as 5.2 inches of runoff can be provided for flood control. The estimated revised costs and economics are given in the summary below.

16. Information received by the Board indicates that the reservoir will intercept numerous farm-tile drainage systems and that suitable adjustments will be necessary. The estimated cost of this work, as furnished by the reporting officers, is also included in the summary below.

17. The Board notes that plans of the District Engineer for the control of underseepage at the dam provide for a 500-foot upstream impervious blanket in conjunction with relief wells at the downstream toe. Since borings at the site indicate 20 to 30 feet of sandy gravel above firm rock, the Board requested that the reporting officers furnish an estimate of cost for an impervious cutoff to firm rock along the axis of the dam. This cost is also included in the following summary:

Summary of revised costs and benefits

First costs		$12,893,000
Annual charges		566,000
(Operation, maintenance, and replacement component)		(48,000)
Annual benefits:		
Flood control	$491,000	
Water quality control	186,000	
Water supply	18,000	
Fish and wildlife	29,600	
Recreation	172,000	
Total	$896,600	$ 896,000
Benefit-cost ratio		1.6

18. The Board concurs in the views of the reporting officers that, since the projected need for water supply is in the distant future and all other project benefits are of a general nature, the total project costs should be borne by the Federal Government, except for recreation as provided herein below. Accordingly, no revised allocation of cost has been prepared. The Board further concurs in the view that when the water supply purpose is needed,

areas for these purposes; bear not less than one-half of the separable project costs allocated thereto; and bear all the costs of operation, maintenance, and replacement of recreation and fish and wildlife lands and facilities. The proposed Act includes provisions responsive to problems of adjustment to a new policy in the case of projects for which preauthorization planning is well advanced. These afford flexibility in regard to the sizing of recreation and fish and wildlife enhancement developments, and in adapting plans to reflect a possible wide range of non-Federal intentions with respect to participation in the cost of these purposes at various stages of project planning and implementation.

22. With respect to limited development for recreation and fish and wildlife enhancement at the proposed Ames project, it is noted from the foregoing summary that the proposal is not dependent upon benefits from those purposes for economic justification. Accordingly, full development of facilities for those purposes will be dependent upon the willingness of non-Federal interests to participate in the costs therefor. The initial cost of such facilities for full development is estimated at $600,000, of which non-Federal interests would be required to contribute $300,000. The annual cost of maintenance and major replacements for such facilities is estimated at $10,000.

23. Since a large part of the proposed storage is planned for conservation purposes, the Board believes that responsible local interests should be required to hold and save the United States free from damages resulting from water-rights claims due to construction and operation of the reservoir for those purposes. The Board further believes that local interests should be required to exercise, to the full extent of their legal capability, control against removal of streamflow made available for water quality control.

24. Recommendations.--Accordingly, the Board recommends authorization for construction and operation of a dam and reservoir on Skunk River at the Ames site about 5 miles upstream from Ames, Iowa, for the purposes of flood control, water quality control, municipal and industrial water supply, recreation, and fish and wildlife, generally in accordance with the plan of the District Engineer as modified herein and with such other modifications as in the

discretion of the Chief of Engineers may be advisable, at an estimated cost to the United States of $12,893,000 for construction and $48,000 annually for operation, maintenance, and major replacements; and that additional detailed studies of fish and wildlife resources be conducted, as necessary after the project is authorized, in accordance with Section 2 of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.); and that such reasonable modifications be made in the authorized project facilities as may be agreed upon by the Director of the Bureau of Sport Fisheries and the Chief of Engineers for the conservation, improvement, and development of those resources: Provided that, prior to construction, local interests furnish assurances satisfactory to the Secretary of the Army that they will:

a. In accordance with the proposed Federal Water Project Recreation Act cited above:

(1) Administer project land and water areas for recreation and fish and wildlife enhancement;

(2) Pay, contribute in kind, or repay (which may be through user fees), with interest, one-half of the separable costs of the Ames Dam and Reservoir allocated to recreation and fish and wildlife enhancement, an amount presently estimated at $300,000, provided that greater participation under the same terms is permissible as may be agreed upon; and

(3) Bear all costs of operation, maintenance, and replacement of recreation and fish and wildlife lands and facilities, such costs presently estimated at $10,000 annually;

Provided that the sizing and responsibility for development, operation, maintenance, and replacement of the recreation and fish and wildlife enhancement features of the reservoir may be modified in accordance with the alternatives provided in the proposed Federal Water Project Recreation Act cited above, depending upon the intentions of non-Federal interests regarding participation in the costs of these features at the time of construction and subsequent thereto, and that appropriate adjustments reflecting such modifications may be made in the allocation of costs to other project purposes;

b. Hold and save the United States free from damages due to water-rights claims resulting from construction and operation of the project; and

c. Exercise, to the full extent of their legal capability, control against removal of streamflow made available for water quality control.

25. The Board further recommends that, following authorization of the Ames Dam and Reservoir, detailed site investigations and design be made for the purpose of accurately defining the project lands required; and that subsequently, advance acquisition be made of such title to such lands as may be required to preserve the site against incompatible development; and that the Chief of Engineers be authorized to participate in the construction or reconstruction of transportation and utility facilities, particularly Interstate Highway No. 35 and adjuncts, in advance of project construction as required to preserve such areas from encroachment and avoid increased cost for relocations.

FOR THE BOARD:

R. G. MacDONNELL
Major General, USA
Chairman

INTERIM REVIEW OF REPORTS
FOR FLOOD CONTROL AND OTHER PURPOSES
ON THE SKUNK RIVER, IOWA - AMES RESERVOIR

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SYLLABUS

This interim report for flood control and other purposes in the Skunk River Basin considers Ames Reservoir for multiple purpose water use. The reservoir is economically justified and would serve needs for flood control, water quality control, water supply, recreation, and fish and wildlife.

Interstate Highway No. 35 will be built in the reservoir area, with construction scheduled to start in the spring of 1965. The Interstate has a strong impact on the cost of Ames Reservoir. If the original construction of the Interstate provides for a level high enough to meet reservoir operation requirements, rather than first being built at low level and then raised to fit reservoir needs, a saving of $1,682,000 is indicated. The incremental cost of raising Interstate 35 high enough to meet reservoir operation requirements, including the cost for adjusting two local roads to the Interstate built to the high level, is estimated at $2,170,000.

The district engineer recommends that the construction of Ames Reservoir be authorized substantially as described in this report and that storage be developed for flood control, water quality control, water supply, recreation, and fish and wildlife, with such modifications thereof as in the discretion of the Chief of Engineers may be advisable, at an estimated first cost of $10,130,000 and an annual cost for maintenance, operation and major replacements of $48,000.

The district engineer further recommends that the sum of $2,170,000 be made available to the Bureau of Public Roads by the spring of 1965 so that Interstate Highway No. 35 through the Ames Reservoir area can be built originally at a level high enough to meet reservoir operation requirements and so that two local roads can be adjusted to fit the Interstate when built at high level.

U. S. ARMY ENGINEER DISTRICT, ROCK ISLAND
CORPS OF ENGINEERS
CLOCK TOWER BUILDING
ROCK ISLAND, ILLINOIS

ADDRESS REPLY TO:
DISTRICT ENGINEER

REFER TO FILE NO. NCRED-R

10 December 1964

SUBJECT: Interim Review of Reports for Flood Control and Other Purposes on the Skunk River, Iowa - Ames Reservoir

TO: Division Engineer
U. S. Army Engineer Division, North Central
Chicago, Illinois

I - AUTHORITY

1. AUTHORITY

The flood control studies in the Skunk River basin are being conducted under the following Congressional authorities:

a. "RESOLVED BY THE COMMITTEE ON FLOOD CONTROL, HOUSE OF REPRESENTATIVES, That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act approved June 13, 1902, be and is hereby requested to review the report on the Skunk River, Iowa, printed as House Document No. 170, 72nd Congress, 1st Session, with a view to determining the advisability of undertaking improvements for flood control in the Skunk River Basin at this time." (Adopted 18 December 1945).

b. "RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the report on the Skunk River, Iowa, printed as House Document Numbered 170, Seventy-second Congress, First Session, and subsequent reports on the Skunk River, Iowa, with a view to determining the advisability of undertaking improvement for flood control and major drainage in the Skunk River Basin at this time." (Adopted 1 June 1948)

2. The Chief of Engineers directed that an interim report be prepared on Ames Dam and Reservoir and that the report be completed by the end of calendar year 1964. This directive was given in the 4th indorsement, dated 11 August 1964 to basic letter dated 19 June 1964 with subject, "Skunk River - Ames Reservoir, Iowa" from Office, Chief of Engineers. A final report will be prepared under the above authorities at a later date to consider other projects to satisfy Skunk River basin needs for flood control and related purposes.

3. The purpose of this report is to present the results of a study on Ames Reservoir for flood control and other purposes and the relationship of such reservoir to the projected Interstate Highway No. 35 which is planned to traverse the reservoir area. This report will present data on project costs and multiple purpose benefits for a range of reservoir elevations and the estimated costs of Interstate 35 modified to conform with the reservoir plans. Costs have been estimated for modification of Interstate 35 for two conditions, first on the assumption that Interstate 35 would be built at low level and then modified to conform to the reservoir plan and second on the assumption that Interstate 35 would be built initially at a level high enough to conform to the reservoir plans.

II - PRIOR REPORTS

4. PRIOR REPORTS

A report, dated 12 February 1930, on the Skunk River, Iowa, was prepared by the district engineer, Rock Island, Illinois, under authority of section 10 of the Flood Control Act approved 15 May 1928; that report was printed as House Document No. 170, Seventy-second Congress, first session. The investigation for that report showed that additional improvement of the river or its tributaries for flood control or flood protection was not economically feasible at that time. Studies of possible future power development indicated that potentialities therefor were generally lacking. No need for development of the streams for other beneficial water uses was indicated.

5. A report, dated 15 December 1934, of a comprehensive investigation of reservoirs in the Mississippi River Basin, was prepared by the Mississippi River Commission and printed as House Document No. 259, Seventy-fourth Congress, first session. Reservoir sites in the Skunk River basin were studied as a part of this report.

6. A report, dated 21 January 1939, on the Mississippi River from Coon Rapids Dam to the mouth of the Ohio River, was prepared by the Division Engineer, Upper Mississippi Valley Division, and printed as House Document No. 669, Seventy-sixth Congress, third session. In that report, construction of certain reservoirs previously included in the comprehensive plan for control of floods on the Mississippi River was considered inadvisable at that time. The report discussed development of additional hydroelectric power at two sites on the Skunk River, but concluded that such development was not economically feasible at that time. Also considered infeasible was the possibility of accomplishing channel rectification and the construction of levees along the Skunk River in Keokuk and Washington Counties, Iowa.

7. A report for flood control on the Skunk River, dated 30 March 1951, was prepared in compliance with the resolutions cited in paragraph 1, above. The District and Division engineers recommended construction of two reservoirs, the Ames Reservoir on the Skunk River, and the Gilbert Reservoir on Squaw Creek, both a few miles upstream from Ames, Iowa. The Board of Engineers for Rivers and Harbors, however, after holding a public hearing, returned the report for further study and consultation with local interests. Since return of the report in October 1952 and prior to the current investigation reported on herein, the investigation on the Skunk River has been in an inactive status.

8. The current investigation was prompted by action by the Iowa Natural Resources Council, bringing the attention of the public to the fact that plans for U. S. Interstate Highway No. I-35, (herein referred to as Interstate 35) and the previously recommended Ames Reservoir were in conflict. The Council was concerned about the possibility of loss of one of the few good reservoir sites in the State. A letter from the Council in this regard and dated 20 March 1963 is included in Appendix D.

9. DESCRIPTION

A map of the Skunk River basin is shown on plate 1. Skunk River rises in Hamilton County in the central portion of Iowa and flows in a southeasterly direction to empty into the Mississippi River at a point about 9 miles downstream from Burlington, Iowa. The river drains 4,355 square miles. The basin shape is long and narrow with a length of about 180 miles and average width of about 24 miles. Its total length is approximately 264 miles and its total fall is about 680 feet. From its source the river flows southward in a postglacial valley to a point a few miles north of Ames, Iowa. The valley in that reach is quite narrow, and shallow except for the lower 5 miles where the bluffs rise 75 to 100 feet above the river bed. From near Ames to its mouth the river flows generally southeastward. A short distance above Ames the river enters a preglacial channel, and immediately below that city, where the main stream is joined by Squaw Creek the valley widens considerably. The valley remains wide through Story, Polk, Jasper, and Marion Counties, reaching its maximum width in Polk County where, in places, the alluvial bottoms reach widths of about two miles. Throughout Mahaska County, the valley bottoms are moderately wide. From near Ames to the eastern boundary of Mahaska County, the formerly meandering river now occupies an artificially straightened channel, the construction of which was accomplished by a number of drainage districts organized under State laws. In Keokuk, Washington, Jefferson, and Henry Counties, the river meanders through somewhat narrower bottoms. In the eastern part of Keokuk County the main stream is joined by the North Skunk River, its largest tributary. Near Rome, in Henry County, the river again enters a postglacial, narrow, steep-walled valley where numerous rock exposures occur in the bed of the stream and in the valley walls. Those characteristics continue to a few miles below Augusta, where the valley again becomes wide, finally merging with the flood plain of the Mississippi River. Drainage areas of the Skunk River and its major tributaries are shown in table 1.

TABLE 1

DRAINAGE AREAS OF SKUNK RIVER AND TRIBUTARIES

River miles above mouth (1)	Description of point on river	Tributary	Tributary drainage area in sq. miles	Main-stream drainage area in sq. miles
0	Jct. Mississippi River	- - - -	- - -	4,355
12.2	U.S.G.S. gage, Augusta	- - - -	- - -	4,303
26.8	Below Jct. Big Creek	Big Creek	167	4,220
43.1	Below Jct. Cedar Creek	Cedar Creek	565	3,990
66.4	Below Jct. Crooked Creek	Crooked Creek	286	3,210
66.6	U.S.G.S. gage (2) Coppock	- - - -	- - -	2,916
93.1	Below Jct. North Skunk	North Skunk	869	2,709
104.1	U.S.G.S. gage, Sigourney	North Skunk	730	- - -
138.6	U.S.G.S. gage, Oskaloosa	- - - -	- - -	1,635
179.5	Below Jct. Indian Creek	Indian Creek	413	1,220
213.3	Below Jct. Squaw Creek	Squaw Creek	227	556
219.0	U.S.G.S. gage, Ames	- - - -	- - -	315
216.9	U.S.G.S. gage, (3) Ames	Squaw Creek	204	- - -

(1) Mileage in this report is as shown in House Document 170.

(2) Discontinued in 1944.

(3) Discontinued in 1927.

10. GEOLOGY

The bedrock beneath most of the watershed of the Skunk River and its tributaries is of the Des Moines series of the Pennsylvanian system. That series is chiefly shales, but contains some sandstones, limestones, and coal. These rocks, as a rule, are not found outcropping. A formation of that series known as the Red Rock sandstone, however, outcrops in the bluffs of the Skunk River near Reasnor and along the North Skunk River near Kellogg. Limestones of the Mississippian system, mostly of the St. Louis formation, outcrop along the valley of the Skunk River above Ames, and in many places along the Skunk and North Skunk Rivers in Mahaska County and downstream therefrom.

11. The superficial deposits of the basin are the materials left by three glacial stages. Most of the basin is covered by Kansan drift. In the lower portion of the basin, in Des Moines and Lee Counties, the Kansan drift is covered by that of the Illinoisan glacial stage. Upstream from a line running northward from near Colfax in Jasper County, the surface deposits are those of the Wisconsin glacial stage. A blanket of loess covers the Kansan and Illinoisan drift, except where removed by erosion. Loess is absent on the surface of the youngest glacial deposits.

12. STREAM SLOPES

Average slopes of the various reaches of the Skunk River are given in table 2.

TABLE 2

STREAM SLOPES
SKUNK RIVER

Portion of river	Length in miles	Average slope feet per mile
Mile 231.4 near Story City to mile 213.3, Jct. Squaw Creek	18.1	5.0
Mile 213.3 to mile 179.5, Jct. Indian Creek	33.8	2.9
Mile 179.5 to mile 154.8	24.7	2.1
Mile 154.8 to mile 138.6, Oskaloosa gage	16.2	1.4
Mile 138.6 to mile 123.2, downstream end of straightened channel	15.4	2.1
Mile 123.2 to mile 66.6, Coppock gage (discontinued)	56.6	1.3
Mile 66.6 to mile 38.3, tailwater Oakland Mills dam	28.3	1.3
Mile 38.3 to mile 6.4, Mississippi River backwater	31.9	1.1

13. CROSS-SECTIONAL DIMENSIONS

The Skunk River channel varies in cross-sectional area from near 1,000 square feet in Story County to near 5,000 square feet near its mouth. The flood plain varies in width up to approximately 2 miles, the widest occurring in Polk County.

14. CHANNEL FLOW CAPACITIES

Bankful flow of the Skunk River varies from about 2,400 cubic feet per second near Ames, Iowa, to approximately 17,000 c.f.s. near Augusta, Iowa.

15. POPULATION

About one-third of the basin population is classed as rural. In 1960, there were eight communities with populations greater than five thousand, as listed below:

Ames	27,003
Newton	15,381
Oskaloosa (1)	11,053
Fairfield	8,054
Grinnell (1)	7,367
Mt. Pleasant	7,339
Washington (1)	6,037
Pella (1)	5,198

(1) These cities are located on the basin rim and are only partially in the watershed.

College populations are included in the above figures. Iowa State University is located in Ames, William Penn College in Oskaloosa, Parsons College in Fairfield, Grinnell College in Grinnell, Iowa Wesleyan College in Mount Pleasant and Central College in Pella.

16. OCCUPATIONS AND INDUSTRIES

The economy of the region of which the Skunk River basin is a part is based on agriculture. Approximately 95 percent of the basin area is in farms. About 60 percent of the farmland is cultivated, about 30 percent is in pasture, and the remaining area is in woodland, streams, buildings, and feed lots. Farms in the upper, northern, part of the basin have a greater percentage of cultivated land than do those in the downstream reaches where the topography is rougher.

17. The importance of manufacturing in the basin is minor in comparison with agriculture. A number of small industries in the various centers of population produce a variety of items, most of which are for use on farms or are processed farm products.

18. NATURAL RESOURCES

Aside from the soil, which is the chief natural resource, there are sand and gravel deposits, limestone, and coal. Mining of the latter, of considerable importance in the first quarter of the century, has practically ceased within the basin. The larger cities and many smaller communities obtain their domestic water supply from the sand and gravel strata beneath the flood plain of the Skunk River. Other centers are supplied by deep wells. Generally, farms are supplied by shallow wells in glacial materials. Numerous low-head power developments were in use from as early as 1835. Most of these furnished mechanical power for grist and saw mills, some were electric power developments. All are now abandoned as power sources.

19. TRANSPORTATION

The Skunk River Basin is well served by many miles of railroad lines and many paved and gravel-surfaced highways. The Skunk River is not considered a navigable stream, and the need for water transportation is not indicated.

IV - HYDROLOGY

20. CLIMATOLOGY

Average annual precipitation in the Skunk River basin varies from 28.61 inches at Webster City in the headwaters to 34.66 inches at Mount Pleasant in the lower reaches. The average annual snowfall depth is about 7 inches. Temperatures have ranged between -37 and 114 degrees.

21. RUN-OFF AND STREAM FLOW DATA

There are presently four stream gaging stations maintained in the basin. Average stream flow at Ames is 132 c.f.s., with a minimum of zero and a maximum recorded of 8,630 c.f.s. At Augusta the average is 2,212 c.f.s. with a minimum of 7 c.f.s. and a maximum of 51,000 c.f.s.

22. Appendix C, Hydrology and Hydraulics, lists the more notable floods that have occurred on the Skunk River during the period of record. That appendix also contains more detailed data on climatology, stream flow data, and other hydrologic and hydraulic aspects of the investigation.

23. STANDARD PROJECT FLOOD

The standard project flood for the reservoir is based on estimated run-off from the storm of 28 to 31 August 1941, originally centered over northern Wisconsin and transposed to Skunk River basin. The peak discharge, or inflow into the reservoir, for the standard project flood is 50,100 c.f.s. The details of the derivation of that flow is contained in Appendix C, Hydrology and Hydraulics.

V - EXTENT AND CHARACTER OF FLOODED AREA

24. EXTENT AND CHARACTER OF FLOODED AREA

The area along the Skunk River subject to overflow downstream from the Ames Reservoir, under present conditions totals about 82,200 acres. The flood plain has been extensively developed for agriculture; approximately 85 percent of the total area subject to inundation is presently devoted to crops and pasture. Corn, soybeans, oats, wheat, and hay are the principal crops grown in the bottom lands. Average annual flood damage to growing crops comprises 83 percent of the estimated total average annual flood damage. Generally throughout the flood plain the bottom land soils produce abundant crops during non-flood years. Property losses in the flooded area include damage to railroads, highways, local roads, utilities, and farm improvements. There are approximately 72 highway bridges and 14 railroad bridges crossing the Skunk River between its mouth and Story City, many of which are occasionally affected by the higher floods.

25. Lands most affected by floods are located along that reach of Skunk River between its mouth and Ames, Iowa. Flood damage occurs predominantly in rural areas. Urban damage, based on existing developments in the flood plain is relatively small, even in very severe floods. Skunk River floods present no particular hazard to human life. The flood plain varies from an average width of about 2 miles in Polk County to an average width of 0.4 mile for the reach downstream from the mouth of the North Skunk River. Near the mouth of the Skunk River the flood plain widens to merge with that of the Mississippi River. The flood plain in Story County below Ames is relatively wide; above that location it is quite narrow and used chiefly for pasture.

VI - FLOOD DAMAGE

26. FLOOD DAMAGE

Periodic flooding of the bottom lands along the Skunk River causes extensive damage to crops and, to less extent, to rural property. Only the very great floods cause damage to urban property. Ames and Augusta are among the few urban areas affected. Damaging floods occur predominantly in May and June, during the early crop season, and are usually of such duration as to cause complete crop losses. Other damaging floods occur, but with moderate frequency, during February, March, and April, a period which precedes crop planting. The ice which usually accompanies floods during that period causes damage to rural property.

27. To ascertain the extent and magnitude of flood losses in the Skunk River Basin, detailed damage surveys were made in 1947 and 1948 for those reaches shown on plate 1. Almost all persons whose properties are located in the flood plain were interrogated. These surveys covered floods which occurred in August 1943, May 1944, May 1945, June 1946 and June 1947. For purposes of this report, data were obtained for each county along Skunk River from the County Conservationist, Soil Conservation Service, on his estimate of present crop distribution and crop yields of flood plain lands. The results of this survey showed that the May 1944 and the June 1947 floods were the most damaging; almost all of the crop and pasture areas inundated produced no harvest in those years. To facilitate handling of the damage data throughout the basin, the flood-plain area was divided into reaches as given in the tabulation on plate 1. The extent of the area flooded and the magnitude of the damage incurred along the Skunk River from its mouth to Ames, Iowa, for the floods of May 1944 and June 1947, are summarized in Appendix A. Floods of other years causing damage in reaches 1 through 4 are as follows (adjusted to November 1964 prices).

Flood Year	Damages				Total area flooded
	Rural property	Urban property	Crop & pasture	Total	
Aug 1943	$ 233,000	$ 0	$1,879,100	$2,112,100	49,150
May 1944	830,000	19,000	3,631,700	4,480,700	80,377
May 1945	172,000	0	1,578,100	1,750,100	42,500
Jun 1946	147,000	1,000	1,431,300	1,579,300	40,600
Jun 1947	364,000	5,000	3,509,000	3,878,000	78,031
Apr 1960	629,000	1,000	0 (1)	630,000	62,300

(1) This flood occurred prior to normal crop-planting season.

28. Flood-damage data obtained for the various floods form the basis for the determination of the estimated average annual damage in the basin. Damage in each of the reaches hereinbefore described was assumed to vary with the stage at an established gaging station designated for each reach. From the recorded flood losses, modified to reflect the existing state of development, character of the overflowed lands, and current (November 1964) prices, relations were derived between flood losses and river stages. From the following chain of relations - stage to damage, stage to discharge, and discharge to frequency - damage frequency relations were developed from which average annual damage was derived. The derivation of these relations is explained in detail in Appendix A. The estimated average annual flood damage for all the reaches mentioned hereinabove is given in table 3.

TABLE 3

ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE - SKUNK RIVER, IOWA

Reach	From (mile)	To (mile)	Average annual flood damage: Crop and pasture	Property (1)	Total
1 (2)	0.0	93.1	$ 296,200	$ 45,200	$ 341,400
2	93.1	179.5	517,400	37,000	554,400
3A	179.5	187.5	59,800	2,000	61,800
3B	187.5	202.1	165,100	93,000	258,100
4	202.1	215.0	92,800	49,000	141,800
			$1,131,300	$226,200	$1,357,500

(1) Includes damage to urban areas.

(2) Does not include area protected by Green Bay Levee and Drainage District No. 2.

VII - EXISTING CORPS OF ENGINEERS PROJECTS

29. EXISTING CORPS OF ENGINEERS PROJECTS

Levees of the Green Bay Levee and Drainage District No. 2, located on the Mississippi River flood plain and bordered on its upstream side by the Skunk River have been improved by the United States under two authorizations. The first improvement under the Flood Control Act of 1936, was begun in 1940 and completed in 1948. The most recent, now under construction, was authorized by the Flood Control Act of 1954.

VIII - IMPROVEMENTS BY OTHER FEDERAL AND NON-FEDERAL AGENCIES

30. IMPROVEMENTS BY OTHER FEDERAL AND NON-FEDERAL AGENCIES

Channel straightening projects have been accomplished in various reaches of the Skunk River during the period 1893 to 1927. The work has been done through drainage districts organized under the several counties involved. Some 90 miles of the Skunk River and 24 miles of the North Skunk River have been straightened. The entire cost of the work was paid by the abutting landowners.

31. In connection with the channel straightening in Polk County, levees were constructed along both sides of the channel and flank levees were built along the Polk-Story County line and along the major tributaries in the Polk County reach. Levees have also been built by individuals to protect small isolated areas at numerous places along the Skunk and North Skunk Rivers.

IX - IMPROVEMENT DESIRED

32. IMPROVEMENT DESIRED

A public hearing was held in Newton, Iowa, on 27 February 1964, attended by 443 persons. One hundred and six written statements were received, in addition to many oral statements heard. Opinion was divided regarding the proposed Ames Reservoir. Landowners located upstream from the dam site were generally opposed to the reservoir project and landowners located downstream from the dam site generally favored the reservoir project. A representative of the Bureau of Public Roads stated that delay in construction of Interstate 35 in the reservoir area would disrupt the schedule for completion of the National System of Interstate and Defense Highways. A resume' of the hearing giving the representative views and opinions of the attendees is contained in Appendix E.

33. Three public hearings were held in connection with the report described in paragraph 7. Two hearings were held in September 1949 at the outset of the study, and a hearing was held in November 1950 to discuss the study findings.

X - FLOOD PROBLEMS, RELATED PROBLEMS AND SOLUTIONS CONSIDERED

34. FLOOD PROBLEM

Damage to crops from flooding occurs throughout the length of the basin. About 95 percent of the average annual flood damage is sustained by agricultural interests. Damage also occurs to railroads and highways. Farm buildings within the area subject to flooding are few. Channel straightening and levee construction by local interests have been only partially successful in reducing flood damage.

35. WATER SUPPLY

The present direct use of stream flow by urban areas is small, with only one community using stream flow directly for parts of its supply. Fifteen communities, including several of the largest in the basin, use shallow wells in the unconsolidated sands and gravels along the stream channels for their water supply. Thirty-five communities use only deep well supplies. Three communities in the southern part of the basin have developed surface storage as a municipal water source.

36. The Regional Office of Public Health Service of the U. S. Department of Health, Education and Welfare, on the basis of a preliminary observation, is of the opinion that the watershed has adequate ground water supplies of acceptable quality to meet projected municipal and industrial water requirements for the next 100 years, with the exception of future needs at Ames, Iowa. At that locality it is estimated that by the year 2060, the requirement will be 20 million gallons per day. By 2020 the city and environs will require half that amount, which, it is estimated, would be the maximum that could be obtained from ground water sources. Water supply storage would be released from the reservoir as required by the city of Ames, using the stream channel to deliver the water. No structural measures would be required for water supply. A preliminary letter report by the Service concerning future needs of water supply, and of water quality control as discussed in the following paragraph, is contained in Appendix D.

37. WATER QUALITY CONTROL

The Regional Office of Public Health Service of the United States Department of Health, Education and Welfare, on the basis of population projections, has estimated minimum requirements for water quality control. As projected, Ames, Iowa, will be the major source of treated wastes discharging into the Skunk River. The Service considers that storage should be provided for releases for proper quality control by the year 1970. To control the quality of water a progressive increase in minimum flow will be required, reaching approximately 75 to 80 cubic feet per second in the year 2060. Such flows would require storage, above natural flows, of approximately 25,000 acre-feet.

38. RECREATION

The Regional Office of the Bureau of Outdoor Recreation of the U. S. Department of the Interior made a preliminary study of recreational needs in the area considered in this report. With respect to a proposed impoundment on the Skunk River above Ames, the Bureau stated that as the only water-oriented recreation area within a 25-mile zone of influence, it would receive optimum utilization. The estimated annual day-use visitation, exclusive of hunting and fishing visitations, would initially be 110,000, and ultimately, on the basis of projected population growth, 180,000. Recreation facilities would be provided, including facilities for camping, picnicking and boating. A preliminary report by the Bureau forms part of Appendix D.

39. IRRIGATION

The Iowa office of the Soil Conservation Service of the United States Department of Agriculture conducted a preliminary study of possible needs for irrigation in the Skunk River Basin. Present use of irrigation in the basin is very limited, and has not increased in the past several years. About 340 acres are presently irrigated. It is indicated that in the foreseeable future there will be no important increase in demand for water for this purpose. A preliminary report of the Soil Conservation Service is contained in Appendix D.

40. HYDROELECTRIC POWER

The Regional Office of the Federal Power Commission made a study of the possibilities of development of hydroelectric power at the Ames Reservoir. The Regional office found that while an installation of some 700 kilowatts would be physically possible, its development would be economically infeasible. A letter report by the Regional office is contained in Appendix D.

41. FISH AND WILDLIFE

The Regional Office of the Bureau of Sport Fisheries and Wildlife of the Fish and Wildlife Service submitted a report on Ames Reservoir, contained in Appendix D. The Bureau finds that the reservoir would result in a net gain in fishery benefits. Losses to wildlife would be satisfactorily mitigated by the creation of waterfowl habitat. Development of subimpoundments would result in a net gain in waterfowl benefits.

42. LEVEES

Studies were made in the early 1950's considering local protection of lands in Story County downstream from Ames, in Polk County, and in part of Jasper County, which reach contains the widest flood plains in the entire basin. The plan was to provide a leveed floodway along the main stem, diversion channels to collect hill run-off and smaller streams, and leveed floodways to carry the flows of the larger hill streams into the main stem. This treatment was found to be economically infeasible.

43. RESERVOIRS

In prior studies it was found that construction of two reservoirs, one on Skunk River a few miles upstream from Ames and the other on Squaw Creek, also a few miles upstream from Ames, would be economically feasible. As stated, this report is primarily concerned with the reservoir on Skunk River, known as the Ames Reservoir. Review of the earlier study substantiates its economic feasibility.

44. In the study for the final report on the Skunk River, consideration will be given to the possibility of reservoirs on tributaries of Skunk River. Consideration will also be given to leveed floodways, especially in the stream reaches containing wide flood plains.

XI - PLAN OF IMPROVEMENT

45. AMES RESERVOIR

The dam site for this reservoir is at mile 220.6, about 5 river miles upstream from the city of Ames. Drainage area above the dam site is 314 square miles. The proposed project would have a capacity of 94,000 acre feet with the top of the flood control pool at elevation 968. The location with respect to the basin is shown on plate 1. Plate 2 is a map of the reservoir and surrounding area. Project features are described in the paragraphs that follow.

46. DAM COMPOSITION

The dam embankment is planned to be of compacted impervious earth. The outlet works will be a gated reinforced concrete cut- and-cover single round conduit located at the base of the right bluff. The gates will be located near the center line of the dam, eliminating the need for a service bridge to the control tower. The spillway will be of the saddle type and gated, located in the left bluff.

47. EMBANKMENT

A plan and sections of the embankment are shown on plate 3. The crest of the dam will be at elevation 985.0, about 75 feet above the narrow flood plain. The length of the dam will be about 600 feet at flood plain level, and about 1,260 feet long at the crest. The downstream slope will be 1 on 3, and seeded. The upstream slope will be 1 on 4, protected with riprap. The crest will be 20 feet wide, surfaced with crushed rock to serve as a maintenance and operation road. The material for the embankment will be mainly glacial till, taken from spillway excavation and from upstream borrow areas. The foundation consists of about 10 feet of alluvial silts and clays, underlain by sand and gravel to a depth of about 30 feet

below the flood plain. The sand and gravel are underlain by limestone. The location of borings made in the foundation are shown on plate 3 and the logs are shown on plate 4. Underseepage will be controlled by relief wells along the downstream toe, and by an upstream impervious blanket.

48. OUTLET WORKS

Discharge from the reservoir will be controlled by a gated conduit. A plan and section of the conduit is shown on plate 3. The conduit will be a single round tube of reinforced concrete, 7 feet in inside diameter. The conduit will be 570 feet long, discharging into a stilling basin 87 feet long and 15 feet wide. Control of discharge from the reservoir will be effected by operation of three gates, located in a widened portion of the conduit near the centerline of the dam. Each gate will be 3 feet wide by 5 feet high, operated with electric motors. The gate tower, being near the centerline of the dam, will require no bridge for access.

49. SPILLWAY

The spillway is of the saddle type, located in the left bluff. It will be 232 feet wide. A concrete weir, crest elevation 953.0, will be surmounted with five tainter gates with top at elevation 969.0. The net opening, after deducting the widths of the tainter gate piers, would be 200 feet. Concrete training walls of the gravity-type will extend 160 feet upstream and 240 feet downstream from the centerline of the weir. The maximum cut for the spillway excavation will be about 40 feet. Side slopes of the spillway cut will be 1 on 3.

50. RESERVOIR

At elevation 968, the flood control pool surface, the reservoir will cover about 4,350 acres. The length will be about 8 miles and about 11 river miles. The land in the reservoir area is presently used mainly for pasture. Approximately 1,100 acres are cultivated for crops. It is estimated that 6,500 acres would be acquired for the project. The lands in the perimeter of the reservoir area are generally cultivated for crops and therefore have a higher value than lands in the reservoir area. Sand and gravel deposits in the reservoir area are worked on an occasional basis. Several local roads traverse the area, the most used of which will require remedial work.

51. Story City, population 1,773 in 1960, is adjacent to the upstream reaches of the reservoir. Water in the reservoir to elevation 968, the top of the flood control pool, would result in no damage at Story City. Water to elevation 975, the maximum reservoir elevation that would result from the standard project flood routed through a full pool, would interfere with operation of the town's sewage treatment plant, but would not damage it.

52. A conservation pool with surface at elevation 949 will be provided. This will contain initially 33,400 acre-feet, of which 8,400 acre-feet are allocated to sedimentation and 25,000 acre-feet are allocated to water quality control and water supply.

53. SEDIMENTATION

No suspended-sediment stations or silt ranges have been established on the Skunk River or its tributaries. From data observed at suspended sediment stations at points in the adjacent watersheds of the Iowa and the Des Moines River, in which the topography and soil types are similar to those in the watershed of the Ames Reservoir, an estimate was made of the quantity of silt expected to be trapped in the reservoir. The size of the watersheds, the characteristics of stream flows, and the ratios of reservoir capacity to drainage area were utilized in the computations. It is estimated that in the Ames Reservoir 8,400 acre-feet of sediment would be trapped in 100 years of operation. Details of the study made for this determination are contained in Appendix C, Hydrology and Hydraulics.

54. MULTIPLE PURPOSE FEATURES

The capacity of Ames Reservoir at elevation 968 is 94,000 acre-feet. The estimated 100-year accumulation of sediment is 8,400 acre-feet, equivalent to reservoir elevation 932. The Public Health Service indicates a need for 25,000 acre-feet of storage for water quality control. The reservoir storage available at elevation 949 is 33,400 acre-feet and the 25,000 acre-feet of storage between elevations 932 and 949 would be allocated to water quality control. If an allocation of storage for water supply is required some time in the future, such an allocation would be made from the storage available between elevations 932 and 949. The 60,600 acre-feet of capacity between elevations 949 and 968 is allocated to flood control. The 60,600 acre-foot allocation to flood control is equivalent

to 3.6 inches of run-off from the watershed upstream from the dam. The reservoir would be operated normally at elevation 949 and the surface area of the reservoir would be 2,100 acres. When the river flow was less than that required to produce the desired water quality downstream from the dam, water would be released from storage and the reservoir level would fall below elevation 949. The minimum reservoir elevation would be 932 and the surface area of the reservoir at that elevation would be 800 acres. The reservoir would provide recreational benefits and minimum recreational facilities, including facilities for camping, picnicking and boating, would be provided as a part of the project. The Fish and Wildlife Service has determined that the reservoir would provide a net benefit to fish and wildlife. Ames Reservoir would be a multiple purpose reservoir with benefits to flood control, water quality control, water supply, recreation, and fish and wildlife.

55. During flood periods, the Ames Reservoir conduit flow will be operated to control flows not to exceed 1,000 c.f.s., insofar as possible, at the Ames gage on Skunk River below Squaw Creek. Conduit flows will be zero during high flow periods on Squaw Creek to provide maximum flood reductions downstream. After a flood, the gates will also be operated to evacuate the flood storage so that the flow on the gage below Squaw Creek does not exceed 1,000 c.f.s. After evacuating flood storage, the conservation pool would be operated at elevation 949.0 except as required to augment low flows for water quality control. During periods of low flow augmentation for water quality control and water supply, the reservoir will be operated so as to maintain a flow of 78 c.f.s. past Ames gaging station. This operation will be accomplished by drafting on the storage allocated to water quality control and water supply. Seventy-eight c.f.s. is approximately 60 percent of the mean annual daily discharge.

56. RELOCATIONS

Remedial work made necessary by construction of the reservoir consists in raising Interstate Highway No. 35 to conform to reservoir plans, and raising of the more important local roads in the reservoir area. The new road and local roads that are to be kept in continuous service will be built to 5 feet above full pool elevation. The average raise in the Interstate embankment will be

about 18 feet, with the maximum raise about 28 feet. All Interstate and new local road embankment slopes will be riprapped up to elevation 955, 6 feet above conservation pool. Minor items of remedial work involve relocation of power and communication lines.

57. INTERSTATE 35

The location of Interstate Highway No. 35 through the reservoir area as proposed by the Iowa Highway Commission, is shown on plate 2. Concerning the possibility of realigning the highway to the east of the reservoir, the Commission stated that the cost would be about the same as through the reservoir but that user costs would be much higher. Design and acquisition of rights-of-way for the reach through the reservoir and for a considerable distance north and south have been completed.

58. If the alignment of the new highway as shown on plate 2 is retained, the highway must be raised a maximum of about 28 feet over that presently planned by the Commission, in order to permit construction and operation of the reservoir. Considerable savings in construction costs will result if the highway is initially built to conform to reservoir needs, rather than raise it after it is built according to present plans.

59. LOCAL ROADS

As shown on plate 2, two roads presently cross the reservoir area and the proposed alignment of Interstate 35. The Iowa Highway Commission plans retention of these roads in its plans for Interstate 35. Neither would have access to the new highway but grade separations would be provided. In the reservoir plans, both these roads would be raised above full pool elevation and bridged over the Interstate Highway, permitting their use at all reservoir stages.

60. The remedial work necessary to maintain two roads that cross Interstate 35 will be accomplished in connection with the Interstate 35 work, to the extent of providing overpasses at Interstate 35 with adequate approaches thereto. Thus, traffic can move over the Interstate during the period between completion of the Interstate and construction of the reservoir project. The remainder of the two roads in the reservoir area can then be raised to reservoir grade when the reservoir project is constructed. Accordingly, funds necessary to build Interstate 35 to conform to reservoir plans should include the amount necessary to complete the local road crossings at the same time.

61. State Road 221 crossing the upper reaches of the reservoir will be raised to above flood control pool. This raise would be independent of any work required at the crossing of road 221 with Interstate 35.

62. A local road running south from Story City crosses two embayments of the reservoir, and at very infrequent intervals the road at these points would be inundated. Remedial work on the bridges at these points is planned to make them submersible for short periods without damage.

63. UTILITIES

Construction of the reservoir will require relocation or abandonment of certain power and telephone lines. In order to assure continuous operation of the sewage treatment plant at Story City during very high stages in the reservoir, it will be necessary to place a sluice gate in the discharge line and provide pumping facilities with a new discharge line.

XII - ESTIMATES OF COSTS

64. ESTIMATES OF COSTS

The estimate of costs is based on November 1964 prices. A summary follows. A detailed estimate is contained in Appendix B.

TABLE 4

SUMMARY OF COSTS

Dam embankment	$ 566,600
Spillway	2,063,400
Outlet works	279,000
Miscellaneous	200,000
Remedial works	1,809,000
Total Construction Cost	$ 4,918,000
Government costs:	
Engineering and Design	585,000
Supervision and Administration	317,000
REAL ESTATE	
Lands and improvements, less salvage, and plus severance damage, 15 percent contingency, and estimated costs of acquisition and resettlement	2,540,000
RECREATION FACILITIES (BOR, present worth)	476,000
INTERSTATE 35	
Increment of cost for constructing Interstate 35 at elevation 973.0 m.s.l. in lieu of original design elevation	1,294,000
TOTAL FIRST COST	$10,130,000

65. The cost for remedial work on Interstate 35 resulting from construction of the Interstate at high level to meet reservoir operation requirements is given in Table 5. This cost is made up of the incremental cost of raising the Interstate and the incremental cost of passing two local roads over the Interstate.

TABLE 5

COST FOR REMEDIAL WORK ON INTERSTATE 35

REMEDIAL WORKS - AMES RESERVOIR		
Road on Section 6/7	$ 1,209,300	
Road on Section 30/31	672,900	
Other roads	65,300	
Utilities	22,500	
	$ 1,970,000	
Remedial costs included in original Interstate 35 design	-161,000	(1)
Remedial Cost Chargeable to the Reservoir	$ 1,809,000	
REMEDIAL WORKS FOR CONSTRUCTION WITH INTERSTATE 35		
Road on Section 6/7	$ 427,000	(2)
Road on Section 30/31	610,000	(2)
	$ 1,037,000	
Increment chargeable to Interstate	161,000	(1)
Increment chargeable to reservoir	$ 876,000	
Increment in cost for constructing Interstate 35 at elevation 973	1,294,000	
Total increment in cost in constructing Interstate 35 at elevation 973	$ 2,170,000	

(1) The estimated cost for passing the road on Section 6/7 under the Interstate and the road on Section 30/31 over the Interstate as originally planned by the Iowa Highway Department is $161,000. This cost can be deducted from the cost of building these roads over the Interstate when raised to elevation 973, to show the increment in cost chargeable to the reservoir.

(2) This figure represents the cost of providing an overpass at Interstate 35, with adequate approaches thereto, when the Interstate has been raised to elevation 973.

XIII - ESTIMATES OF ANNUAL CHARGES

66. ESTIMATES OF ANNUAL CHARGES

First cost	$10,130,000	
Interest during construction 1/2 of 2-year construction period at 3.125%	316,500	
	$10,446,500	
Interest, $10,446,500 @ 3-1/8%		$326,500
Amortization $10,446,500, 100 years, 3-1/8%		15,800
Operation and maintenance		40,000
Replacements:		
Gates and operating equipment	$ 500,000	
Present worth of $500,000 - 33 years hence, $500,000 x 0.36223 =	181,115	
Present worth of $500,000 - 67 years hence, $500,000 x 0.12724 =	63,620	
Total	$ 244,735	
Interest, $244,735 @ 3-1/8%		7,650
Amortization, $244,735, 100 years @ 3-1/8%		370
Loss of taxes (1% of Real Estate costs)		26,500
Total Annual Charges		$416,820

XIV - ESTIMATE OF BENEFITS

67. ESTIMATE OF BENEFITS

Operation of Ames multiple-purpose reservoir would produce flood control, water quality control, water supply, fish and wildlife, and recreation benefits. The derivation of values of these benefits is given in Appendix A.

a. Flood control. The reservoir was operated theoretically during the period of flow record to develop modified flow frequency curves for the flood damage reaches downstream from the dam site (see Appendix C, Hydrology and Hydraulics). Flood control benefits credited to the project, in the amount of $369,400 annually, are derived from reduction of average annual flood damage to crops and rural property in the flood plain lands located downstream from the dam site.

b. Water quality control and water supply benefits. The Regional Office of the U. S. Public Health Service established the needs for reservoir storage for purposes of pollution abatement and water supply. The values assigned for these needs were computed as the annual cost of a single-purpose reservoir to provide the required stream flows at Ames and amounted to $186,000 and $18,000 (discounted values), respectively.

c. Fish and wildlife. The Regional Office of the U. S. Fish and Wildlife Service has estimated that operation of the reservoir will result in substantial losses to wildlife habitat, but in a net annual gain to fishery. Fishery losses in the stream inundated by the reservoir would be more than offset by gains owing to the conservation pool and to increases in flow during natural low flow periods in the Skunk River downstream from the reservoir. The net annual benefit to the fishery from the establishment of a pool in Ames Reservoir for conservation uses has been estimated by the U. S. Fish and Wildlife Service to be about $29,600. It is considered that the value of the loss to wildlife in the reservoir area will be offset by value of the improvement of fishery below the dam. These respective values were not estimated by the Service. The net benefit to fish and wildlife used for this report was taken as $29,600 annually.

d. Recreation. The Regional Office of the Bureau of Outdoor Recreation furnished estimates of annual visitor-days attendance at the Ames Reservoir for which conservation storage will be included in the plan of improvement. The Bureau estimated the visitor-day attendance to be 110,000 for the initial years of the project (years 1-5) and ultimate visitor-days of 180,000 (years 6-35) and then remain constant for the remaining years of project life. A unit value of seventy-five cents per visitor-day was used to compute the annual values of general recreation benefits (not including fish and wildlife recreation) in amounts of $82,500, $135,000, and $135,000, respectively, for the above-stated periods. The equivalent annual value of this benefit, discounted to present worth is, therefore, $123,300.

e. Irrigation. The Iowa office of the U. S. Department of Agriculture, Soil Conservation Service, in their study of needs for irrigation storage stated that although an irrigation potential in the valley below Ames dam site is indicated, it appeared that demand for reservoir storage for such purpose is at the present time limited. On the basis of the report of the Soil Conservation Service, no irrigation benefits were credited to the Ames Reservoir project.

f. Hydroelectric power. The Regional Office of the Federal Power Commission submitted a letter report to the effect that a hydroelectric power development at this location with top of power pool at elevation 949 would be economically infeasible at this time.

68. SUMMARY OF PROJECT BENEFITS

The total estimated benefits evaluated for the Ames Reservoir are summarized in the following tabulation:

Type of benefit	Annual value
Flood control	$ 369,400
Water quality control	186,000
Water supply	18,000
Fish and wildlife	29,600
Recreation	123,300
	$ 726,300

XV - PROJECT FORMULATION

69. PROJECT FORMULATION AND ECONOMIC JUSTIFICATION

Studies were made of costs for Ames Reservoir at the site selected for various capacities of reservoir storage. The studies were based on raising the spillway crest by 2-foot increments between elevations 957.5 and 968.0. Considering single-purpose use of a reservoir for flood control, deducting sedimentation storage, flood control benefits were determined based on modification of flow frequencies in the downstream reaches for the varying capacities of flood control storage, as discussed in detail in Appendix A. A plot of the annual costs and annual flood control benefits showed that the maximum excess of benefits over costs for a single-purpose flood control reservoir would obtain with a pool elevation of 968.0, containing 85,600 acre-feet for flood control capacity.

70. Total project benefits in the amount of $726,300 as compared to annual charges of $416,820 results in a benefit-to-cost ratio of 1.7.

71. Storage requirements established by the U. S. Public Health Service for water quality control and for water supply needs were stated to be 25,000 acre-feet commencing in the year 1970 (considered by the Service to be the present year) and 10,000 acre-feet commencing in year 2020 for the respective uses. Inasmuch as the needs for water supply will not be required until the year 2020 it was considered that allocation of a 25,000 acre-foot pool for joint use would fulfill the needs of pollution abatement and water supply throughout the project life. This consideration is based on the premise that local interests would, over the next 50 years, provide advanced treatment of pollutants and, therefore, lessen the requirements of storage needs for this purpose during the second 50 years of project life. With allocation of 25,000 acre-feet for conservation purposes, the net flood control storage would be reduced from 85,600 acre-feet to 60,600 acre-feet.

XVI -ALLOCATION AND APPORTIONMENT OF COSTS

72. ALLOCATION OF COSTS

The allocation of costs between project purposes is given in the tabulation which follows:

ALLOCATION OF COSTS

Purpose	Allocated cost
Flood control	$ 5,430,000
Water quality control	3,262,000
Water supply	243,000
Fish and wildlife	344,000
Recreation	851,000
Total	$10,130,000

73. The reservoir will be operated for multiple-purpose water use, including benefits for flood control, water quality control, recreation, fish and wildlife, and water supply. The uses other than water supply are considered to be general in nature and therefore the costs allocated to these purposes are properly Federal costs. In the study by the Regional Office of the Public Health Service, a determination was made that 25,000 acre-feet of storage should be made available for water quality control. The year of first need for water quality releases is 1970. In the case of water supply, the indicated year of first need is 2020. No separate allocation of storage is made for water supply at this time. If the need for storage in Ames Reservoir for water supply develops as forecast by the

Public Health Service, an allocation of storage can be made at the time of need. Since the forecast year of first need for water supply is many years into the future, the entire cost for construction of the reservoir should be considered to be a Federal responsibility. If and when the water supply purpose is used, the community requesting such an allocation must agree to contribute toward the cost of the reservoir project in accordance with the policy in cost-sharing prevailing at that time.

XVII - COORDINATION WITH OTHER AGENCIES

74. COORDINATION WITH FEDERAL AGENCIES

The agencies consulted and a brief statement concerning their views or recommendation are given in the following subparagraphs. Because of the short time allowed, reports or statements submitted are to be considered as preliminary. These reports or statements are contained in Appendix D.

a. Regional Office of Public Health Service. This agency gave its views on the adequacy of present water supplies and the future needs of water supply and water quality control, as discussed in paragraphs 35 through 37.

b. Regional Office of The Bureau of Outdoor Recreation stated that there is a definite need for water-oriented recreation in the area of the proposed Ames Reservoir (see paragraph 38).

c. Iowa office of The Soil Conservation Service found that there is little irrigation practiced in the basin and does not expect that the demand for water for this purpose will increase substantially in the foreseeable future.

d. Regional Office of The Federal Power Commission is of the opinion that the development of hydroelectric power in connection with the Ames Reservoir would be infeasible.

e. Regional Office of The Bureau of Sport Fisheries and Wildlife of the Fish and Wildlife Service submitted a report on Ames Reservoir. Recommendations in the report are listed below. These recommendations will be considered during the preconstruction planning phase of the project.

(1) That additional detailed studies of fish and wildlife resources be conducted, as necessary, after the project is authorized, in accordance with Section 2 of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq); and that such reasonable modifications be made in the authorized project facilities as may be agreed upon by the Director of the Bureau of Sport Fisheries and Wildlife and the Chief of Engineers, for the conservation, improvement and development of those resources.

(2) That prior to establishment of clearing specifications and determination of plans for recreational development, a joint discussion be held between representatives of the Corps of Engineers, the Iowa Conservation Commission, the Bureau of Outdoor Recreation, and this Bureau, to formulate mutually acceptable plans for reservoir clearing, zoning, and provision of public access facilities.

(3) That selected project lands and waters below the fee-taking line be made available to the Iowa Conservation Commission under the provisions of the terms of a General Plan, in accordance with Section 3 of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

(4) That Federal lands and project waters in the project area be open to public use for hunting and fishing so long as title to the lands and structures remains in the Federal Government, except for sections reserved for safety, efficient operation, or protection of public property.

(5) That leases of Federal land in the project area reserve the right of public use of such land for hunting and fishing.

(6) That the conservation, improvement, and development of fish and wildlife resources be among the purposes for which the project is to be authorized.

(7) That all lands necessary for carrying out the various purposes of the project be acquired in accordance with the provisions of the Joint Policy of the Departments of the Interior and of the Army relative to reservoir project lands of February 16, 1962 and that flowage easements be acquired only on those lands found not to have substantial value for recreation or fish and wildlife purposes.

(8) That rough fish populations upstream from the dam site be eliminated prior to dam closure wherever practicable and that project operations allow for continued control of rough fish. It is further recommended that a low-level outlet be incorporated in the design of the dam to help implement this phase of fishery management.

(9) That consideration be given to development of subimpoundments to insure that waterfowl and other aquatic wildlife are provided optimum with-the-project living conditions.

(10) Reservoir operations be reviewed with the Iowa Conservation Commission and this Bureau to assure maximum fish and wildlife benefits consistent with other needs of the project.

(11) The largest possible conservation pool, consistent with other needs of the project, be favored in project planning, in order to realize the maximum over-all fish and wildlife values.

f. Regional Office of The Bureau of Public Roads furnished information on the schedule for design, right-of-way acquisition, and construction of the Interstate 35 through the reservoir area. Design of the Interstate and acquisition of right-of-way in the reservoir area are completed. Construction is scheduled to start in the reservoir area in the spring of 1965 and to be completed in 1966.

75. COORDINATION WITH NON-FEDERAL AGENCIES

a. The Iowa Highway Commission furnished information concerning Interstate 35. Plans for the highway as presently proposed through the reservoir area were furnished by this agency. Assistance was furnished on estimating the costs for modification of the highway to fit reservoir needs.

b. The Iowa Conservation Commission worked with the U. S. Fish and Wildlife Service and reviewed the report prepared by the Service. This agency was also consulted by the Bureau of Outdoor Recreation.

c. The Iowa Department of Health and the Iowa Natural Resources Council furnished data to the Public Health Service for use in the study on water quality control and water supply.

XVIII - DISCUSSION

76. DISCUSSION

Ames Reservoir is a multiple-purpose reservoir and will provide benefits for flood control, water quality control, water supply, recreation, and fish and wildlife. The flood control benefits will be experienced in the wide flood plain bordering Skunk River downstream from Ames. The most substantial benefits will be in the reach from Ames to the mouth of Indian Creek, a distance of about 35.5 miles. The Regional Office of U. S. Public Health Service has studied needs for water quality control and water supply in the valley downstream from Ames Reservoir. An allocation of storage is made for those purposes. Since the need for water supply storage is so far in the future, no provisions have been made for local participation in project costs at this time. The Regional Office of the Bureau of Outdoor Recreation has determined that the reservoir will be beneficial for camping, picnicking, boating, fishing and hunting. The project will include minimum facilities for recreation as a part of the first construction. Additional recreation facilities will be added as the need therefor develops. The Regional Office of Fish and Wildlife Service studies show that the project will produce a net gain to fish and wildlife.

77. Other possible project purposes have been considered. The Iowa Office of the Soil Conservation Service reports that there is now little irrigation of agricultural land in the flood plain of Skunk River. The rainfall in the area is generally adequate for agricultural needs and there is little likelihood that a widespread need for irrigation water will arise in the near future. The Regional Office of the Federal Power Commission has considered possibilities for hydroelectric power, but reports that economic justification for power development at Ames Reservoir is lacking.

78. This interim report has been prepared because of the impending construction of Interstate 35 through the Ames Reservoir area. The Interstate will have a strong impact on the cost for Ames Reservoir. Construction of the Interstate in the vicinity of the reservoir is scheduled to start in 1965. If the Interstate can be built originally at a level high enough to meet reservoir operation requirements, the incremental cost above construction of the

Interstate at the low level presently planned would be about $1,294,000. If the Interstate is built as presently planned and then is raised to fit reservoir needs, the additional cost for the Interstate in the reservoir area would be about $2,815,000. Thus, a saving of about $1,521,000 would obtain if the Interstate through the reservoir area is built originally at a level high enough to meet reservoir operation requirements. The original Iowa Highway Department cost estimate for passing two local roads across the Interstate, $161,000, is not included in these figures. Therefore the total saving is $1,682,000.

79. A determination has been made of the incremental cost between building the Interstate at low level through the reservoir area and building the Interstate initially at a level high enough to fit reservoir operation requirements. This incremental cost is estimated at $1,294,000. The Iowa Highway Commission plans provide for passing two local roads in the reservoir area under or over the Interstate highway. The incremental cost of raising these local roads to pass them over the Interstate at high level is estimated at $876,000. The Interstate will be completed several years before construction of the reservoir project can be completed. By transferring to the Bureau of Public Roads the funds required to adjust the two local roads to the Interstate when built at high level, interference to traffic on the two local roads will be minimized. Thus, the sum of $2,170,000 should be made available to the Bureau of Public Roads to provide for the original construction of Interstate Highway No. 35 through the reservoir area at a level high enough to fit reservoir operation requirements and to provide for passing two local roads over the Interstate when constructed to this high level. The amount of $2,170,000 is included in the aforementioned estimated first cost of the reservoir of $10,130,000.

80. A final report on Skunk River Basin will be made in response to the Congressional resolutions given in paragraph 1. This report will consider the basin-wide needs for water resource development. Reservoirs in addition to Ames Reservoir will be studied and, where concentrations of flood damage are experienced, consideration will be given to local flood protection works. Ames Reservoir, situated in the headwaters of Skunk River Basin, will fit into the comprehensive plan for water resource development to be formulated in the final report. Likewise, the comprehensive plan for water resource development for Skunk River Basin will fit into the over-all basin plan for the Upper Mississippi River.

81. Ames Reservoir is estimated to cost $10,130,000 considering the Interstate 35 built initially to meet reservoir operation requirements. Annual charges are $416,820 and annual benefits are $726,300. The benefit-to-cost ratio is 1.7. Since at this time all of the project benefits are considered to be general in nature, all costs for Ames Reservoir should be borne by the Federal Government. If a need for water supply arises in the future and storage is reserved for that purpose, the local agency requesting the storage will contribute toward the project cost in accordance with cost-sharing procedures then in use.

XIX - CONCLUSIONS

82. CONCLUSIONS

Ames Reservoir is a multiple-purpose reservoir which would serve needs for flood control, water quality control, water supply, recreation, and fish and wildlife. The proposed reservoir is economically justified and will fit into the comprehensive plan for water resource development to be formulated for Skunk River Basin. Interstate Highway No. 35 is planned to be built in the reservoir area with construction scheduled to start in 1965. If the original construction of the Interstate highway provides for a level high enough to meet reservoir operation requirements, rather than first being built at low level and then raised to fit reservoir needs, a saving of $1,682,000 is indicated. The increased cost of constructing the Interstate highway at a level high enough to meet reservoir operation requirements, including the costs for adjusting two local roads to the Interstate highway built to the high level, is estimated at $2,170,000. That sum should be made available to permit Interstate No. 35 to be built at high level through the reservoir area.

XX - RECOMMENDATION

83. RECOMMENDATION

I recommend:

a. Construction of a dam and reservoir on Skunk River, located upstream of the city of Ames, for flood control, water quality control, water supply, recreation, and fish and wildlife, generally in accordance with the plan of improvement in this report and with such modifications thereof as in the discretion of the Chief of Engineers may be advisable, at an estimated Federal construction cost of $10,130,000 and $48,000 annually for operation, maintenance and major replacements.

b. Early coordination with the Bureau of Public Roads so that Interstate Highway No. 35 through the Ames Reservoir area can be built originally at a level high enough to meet reservoir operation requirements and so that two local roads can be adjusted to fit the Interstate when built at high level.

c. That additional detailed studies of fish and wildlife resources be conducted, as necessary, after the project is authorized, in accordance with Section 2 of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq); and that such reasonable modifications be made in the authorized project facilities as may be agreed upon by the Director of the Bureau of Sport Fisheries and Wildlife and the Chief of Engineers, for the conservation, improvement and development of those resources.

H. B. COFFMAN, JR.
Colonel, Corps of Engineers
District Engineer

NCDED-PP (10 Dec 64-NCRED-R) 1st Ind
SUBJECT: Interim Review of Reports for Flood Control and Other Purposes on the Skunk River, Iowa - Ames Reservoir

U. S. Army Engr. Div., North Central, Chicago, Ill., 23 December 1964

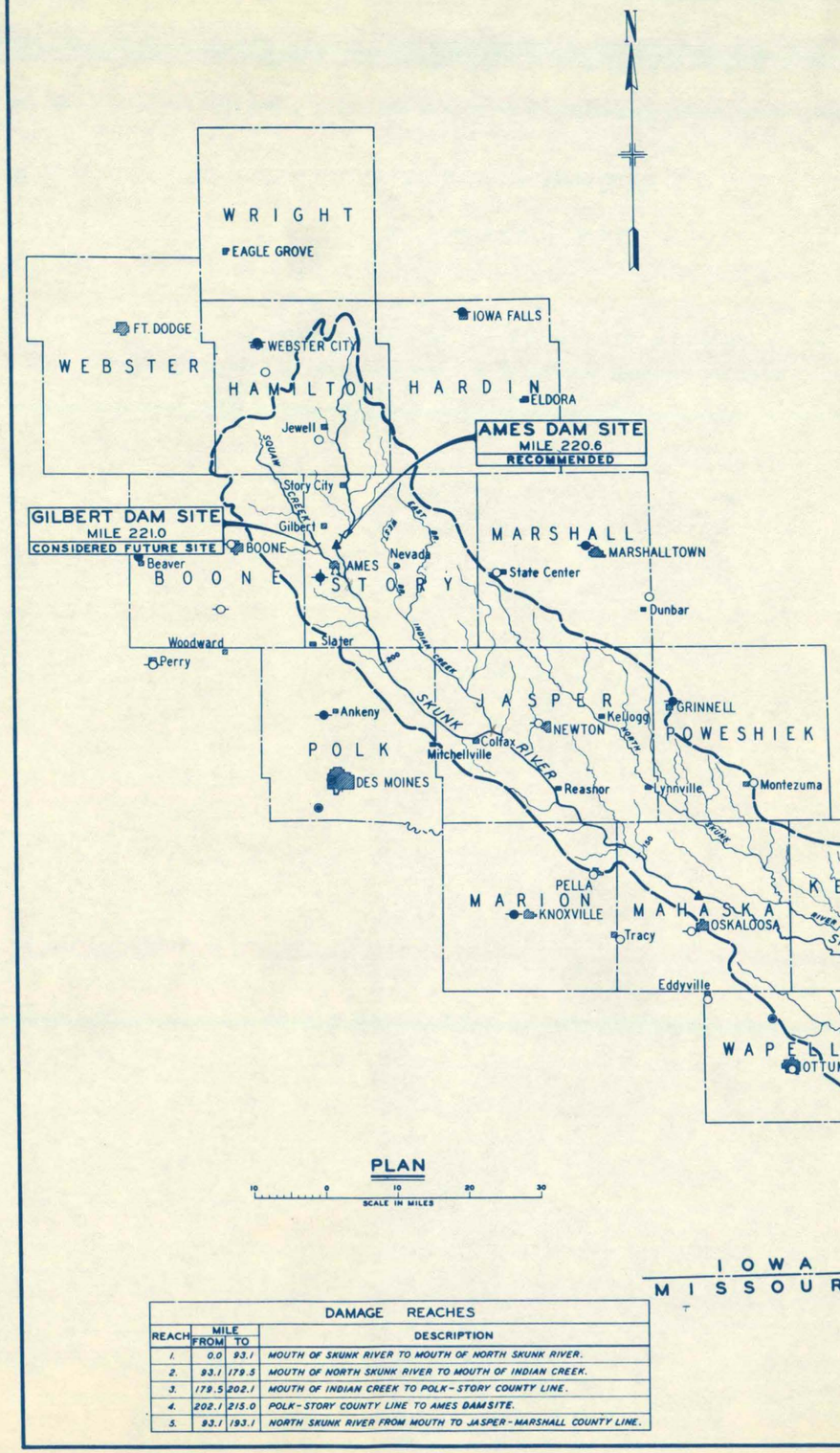
TO: Resident Member, Board of Engineers for Rivers and Harbors, Washington, D. C.

I concur in the conclusions and recommendation of the District Engineer.

ROY T. DODGE
Brigadier General, USA
Division Engineer

CORPS OF ENGINEERS

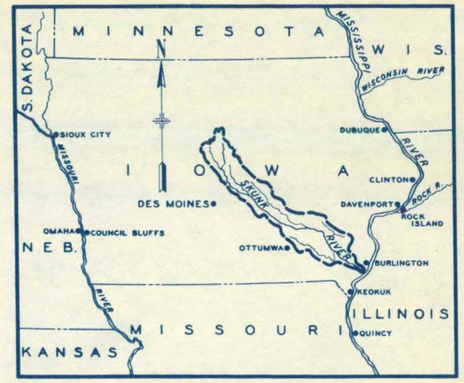
U.S. ARMY



PLAN

10 0 10 20 30

SCALE IN MILES



VICINITY MAP

25 0 25 50 75

SCALE IN MILES

PROFILES

LEGEND:

- OUTLINE OF WATERSHED.
- MILES ABOVE MISSISSIPPI RIVER.

GAGES — RECORDING / NON-RECORDING

- PRECIPITATION STATION.
- PRECIPITATION AND TEMPERATURE.
- PRECIPITATION, TEMPERATURE AND EVAPORATION.
- COMPLETE METEOROLOGICAL STATION.
- RIVER GAGE RATED.
- DISCONTINUED RIVER GAGE.

REFERENCE:

1. MILEAGES ARE TAKEN FROM HOUSE DOCUMENT NO. 170, 72ND CONGRESS, 1ST SESSION.

DAMAGE REACHES

REACH	MILE FROM	MILE TO	DESCRIPTION
1.	0.0	93.1	MOUTH OF SKUNK RIVER TO MOUTH OF NORTH SKUNK RIVER.
2.	93.1	179.5	MOUTH OF NORTH SKUNK RIVER TO MOUTH OF INDIAN CREEK.
3.	179.5	202.1	MOUTH OF INDIAN CREEK TO POLK-STORY COUNTY LINE.
4.	202.1	215.0	POLK-STORY COUNTY LINE TO AMES DAMSITE.
5.	93.1	193.1	NORTH SKUNK RIVER FROM MOUTH TO JASPER-MARSHALL COUNTY LINE.

SKUNK RIVER, IOWA
AMES RESERVOIR
WATERSHED MAP & PROFILE

IN 4 SHEETS

SHEET NO. 1

CORPS OF ENGINEERS, U. S. ARMY
ROCK ISLAND, ILLINOIS

ROCK ISLAND DISTRICT
DECEMBER 1964

SUBMITTED: Leonard A. Cadson, CHIEF PLANNING & REPORTS BR

RECOMMENDED: J.H. Reid, CHIEF ENGINEERING DIVISION

APPROVED: N.B. Clapham Jr., COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

DRAWN BY R.J.M.

FILE NO

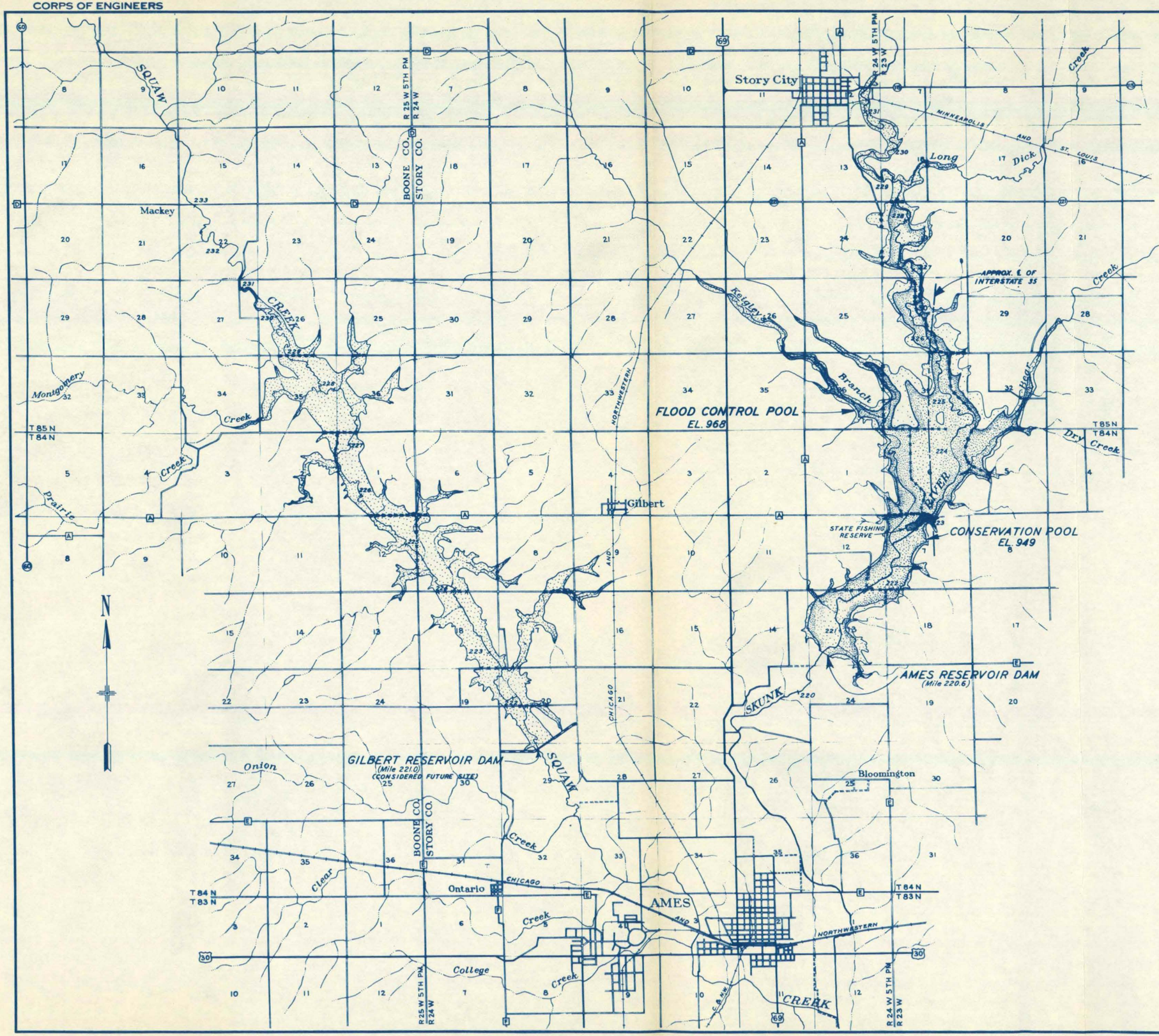
CHECKED BY

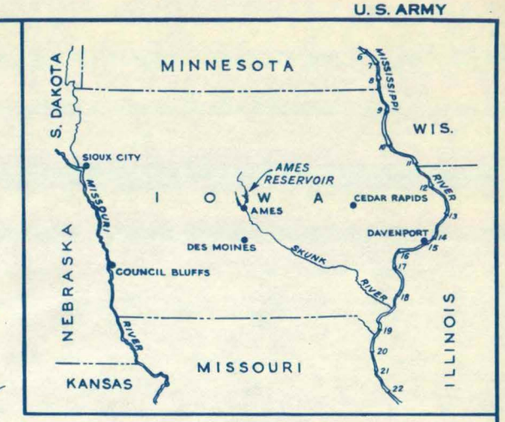
TO ACCOMPANY INTERIM REPORT DATED 10 DECEMBER 1964

PLATE 1

CORPS OF ENGINEERS

U. S. ARMY





VICINITY MAP

25 0 25 50 75
SCALE IN MILES

REMEDIAL WORK:

- No work required on road.
- Road to be raised 5 feet above spillway crest.
- New Road.
- Road to be abandoned.
- Road to be submergible.

LEGEND:

- Interstate
- U.S. Highways
- State Highways
- County Highways
- Paved Roads
- Other Roads

NOTES:

1. RIVER MILES ORIGINATE AT MOUTH OF SKUNK RIVER.
2. ELEVATIONS BASED ON SEA LEVEL DATUM OF 1929.

SKUNK RIVER, IOWA
AMES RESERVOIR
LOCATION MAP

IN 4 SHEETS — SCALE IN MILES — SHEET NO. 2

CORPS OF ENGINEERS, U. S. ARMY
ROCK ISLAND, ILLINOIS

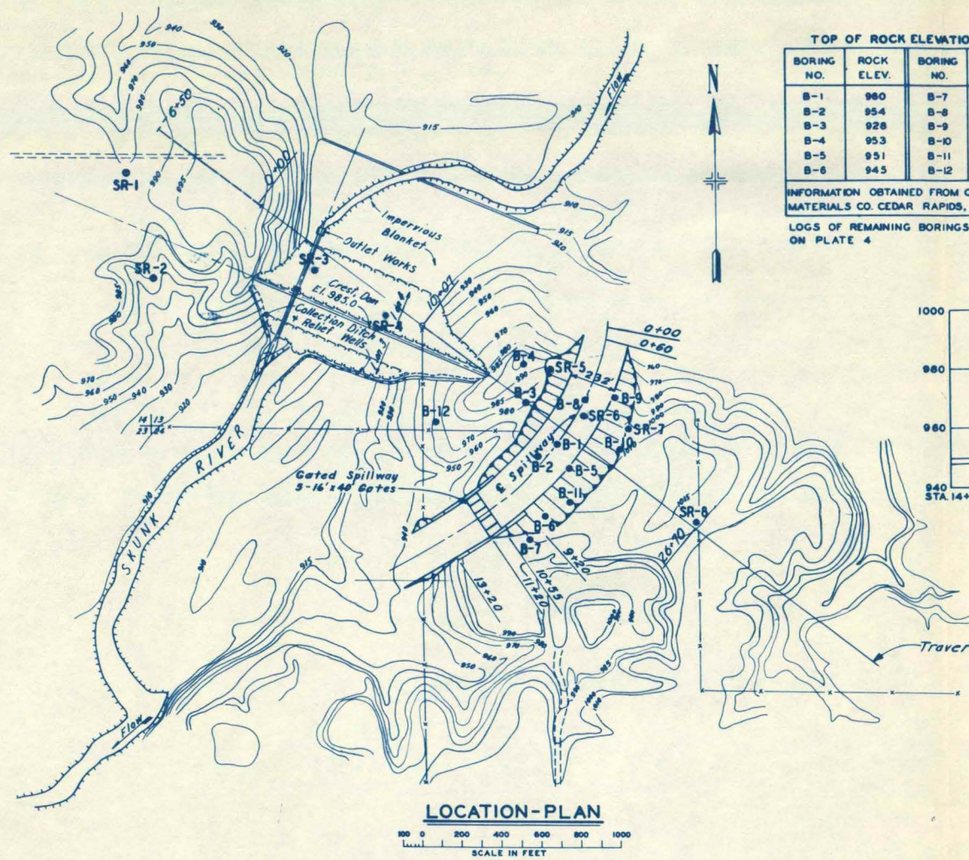
ROCK ISLAND DISTRICT
DECEMBER 1964

SUBMITTED: Leonard A. Carlson, CHIEF, PLANNING & REPORTS BR.
RECOMMENDED: J. K. Reid, CHIEF, ENGINEERING DIVISION
APPROVED: H. B. Crabtree Jr., COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

DRAWN BY: H.D.J.
CHECKED BY:
FILE NO.

TO ACCOMPANY INTERIM REPORT DATED 10 DECEMBER 1964

PLATE 2



LOCATION-PLAN

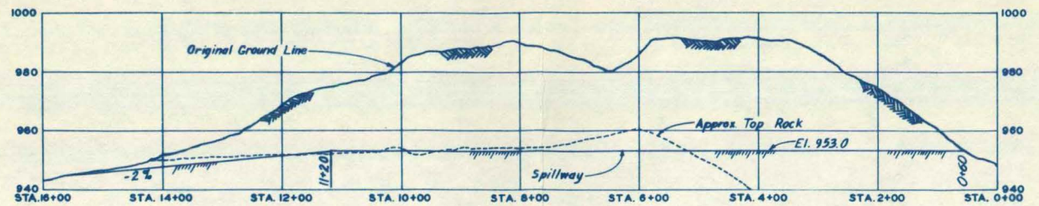
SCALE IN FEET 100 0 200 400 600 800 1000

TOP OF ROCK ELEVATIONS

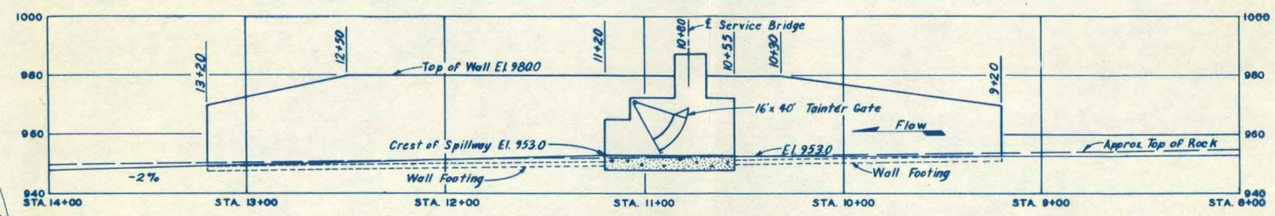
BORING NO.	ROCK ELEV.	BORING NO.	ROCK ELEV.
B-1	960	B-7	962
B-2	954	B-8	944
B-3	928	B-9	948
B-4	953	B-10	963
B-5	951	B-11	963
B-6	945	B-12	932

INFORMATION OBTAINED FROM CONCRETE MATERIALS CO. CEDAR RAPIDS, IOWA

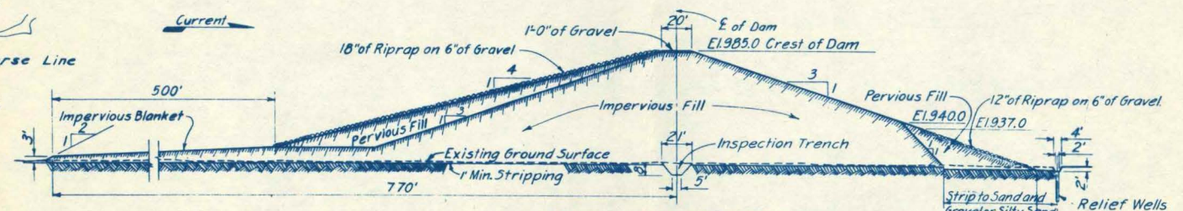
LOGS OF REMAINING BORINGS SHOWN ON PLATE 4



℄ SPILLWAY-PROFILE

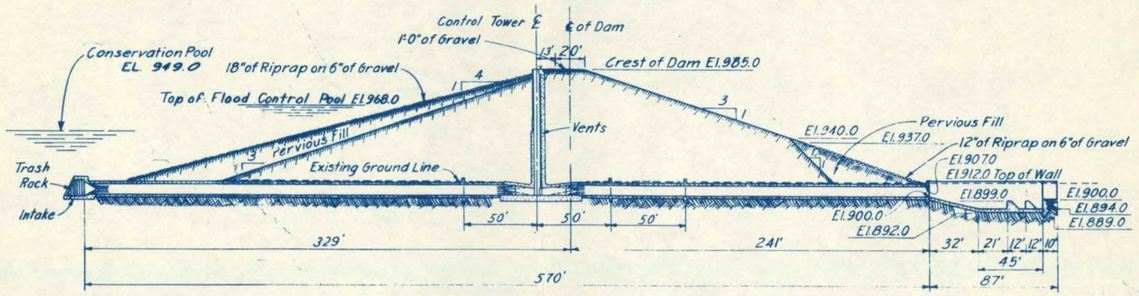


SECTION THRU SPILLWAY



TYPICAL EMBANKMENT SECTION

SCALE IN FEET 10 0 50 100 150



SECTION THRU OUTLET WORKS

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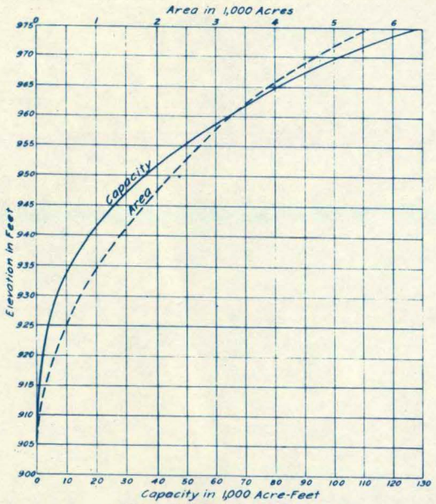
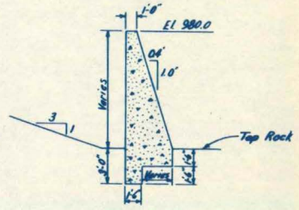
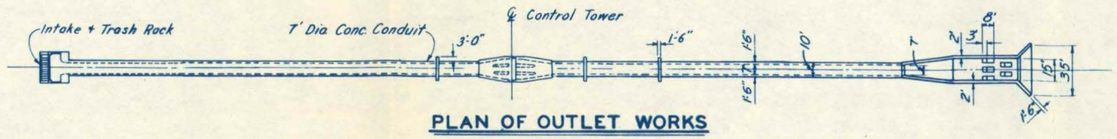


AREA CAPACITY CURVES



TYPICAL SPILLWAY WALL-SECTION

SCALE IN FEET 10 5 0 10



PLAN OF OUTLET WORKS

SCALE IN FEET 10 0 50 100 150

SKUNK RIVER, IOWA
AMES RESERVOIR
DAM AND SPILLWAY
GENERAL PLAN AND SECTIONS

IN 4 SHEETS

SHEET NO. 3

CORPS OF ENGINEERS, U. S. ARMY
ROCK ISLAND, ILLINOIS

ROCK ISLAND DISTRICT
DECEMBER 1964

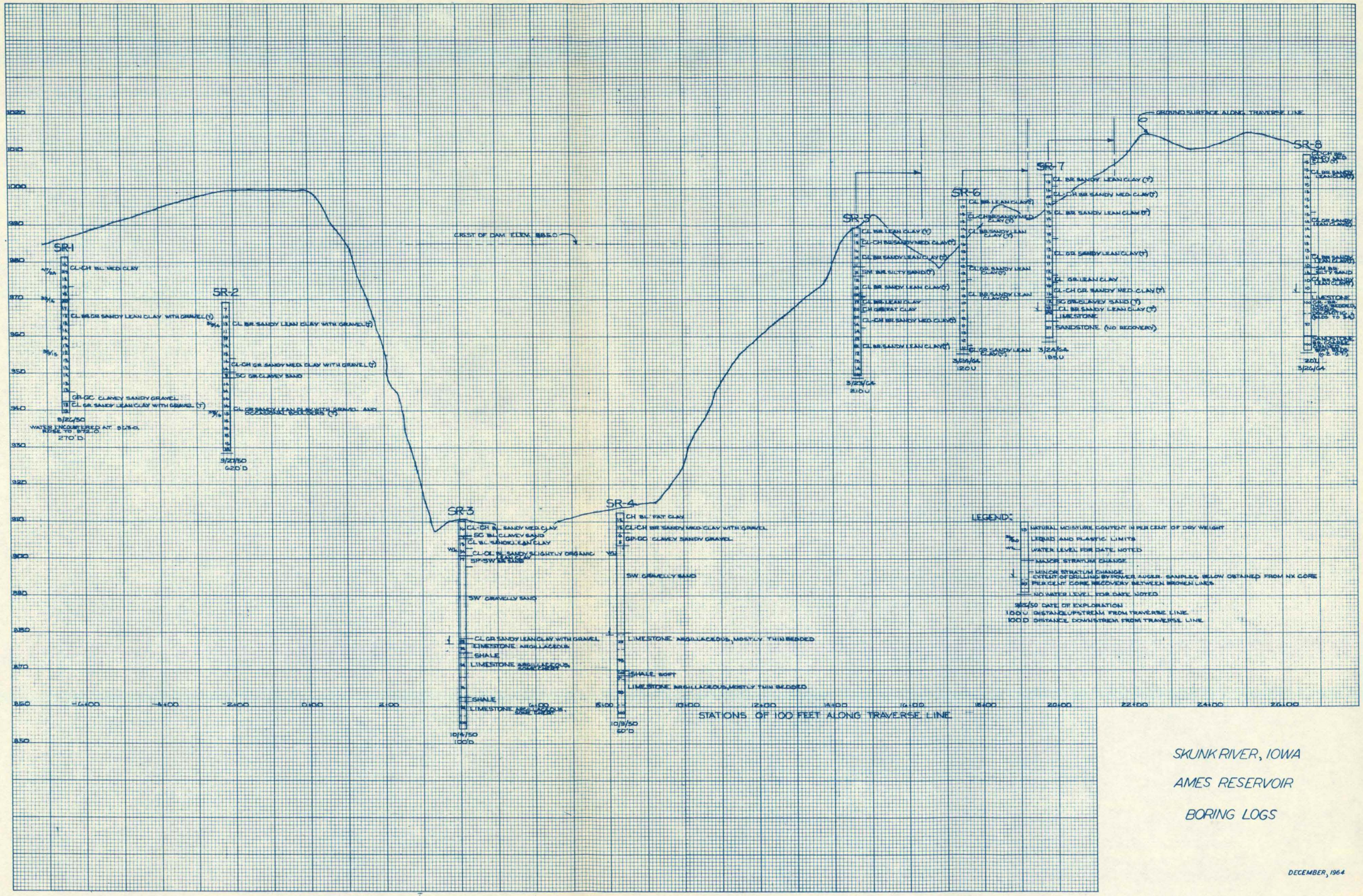
SUBMITTED: Lloyd A. Carlson, CHIEF, PLANNING & REPORTS BR.

RECOMMENDED: J. K. Peil, CHIEF, ENGINEERING DIVISION

APPROVED: N. A. Colonna Jr., COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DRAWN BY: T.L.S.
CHECKED BY:
FILE NO.

TO ACCOMPANY INTERIM REPORT DATED 10 DECEMBER 1964



SKUNK RIVER, IOWA

AMES RESERVOIR

BORING LOGS

DECEMBER, 1964

INTERIM REVIEW OF REPORTS
FOR FLOOD CONTROL AND OTHER PURPOSES
ON THE SKUNK RIVER, IOWA - AMES RESERVOIR

APPENDIX A

ECONOMIC ANALYSIS

U. S. Army Engineer District, Rock Island
Corps of Engineers
Clock Tower Building
Rock Island, Illinois

APPENDIX A

ECONOMIC ANALYSIS

INTERIM REVIEW OF REPORTS FOR FLOOD CONTROL AND OTHER PURPOSES ON THE SKUNK RIVER, IOWA - AMES RESERVOIR

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ECONOMIC ANALYSIS

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APPENDIX A

ECONOMIC ANALYSIS

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(continued)

TABLES
(continued)

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INTERIM REVIEW OF REPORTS
FOR FLOOD CONTROL AND OTHER PURPOSES
ON THE SKUNK RIVER, IOWA - AMES RESERVOIR

APPENDIX A

ECONOMIC ANALYSIS

SECTION I - INTRODUCTION

1. Purpose and scope. This economic appendix discusses the evaluation of flood control and other benefits which would accrue through the operation of flood control and multiple purpose improvement for the Ames Reservoir. It describes the method of determining the annual flood damage, both under existing conditions and with the Ames Reservoir operating. It compares the resulting benefits from flood control and other purposes with corresponding project costs and sets forth the economic basis for the scale of development of the recommended project.

2. Description of the area. The Skunk River basin contains 4,325 square miles in central Iowa. The economy of the basin is primarily agricultural, and the towns serve mainly as marketing and distributing centers for the surrounding agricultural areas. Nearly all of the communities are situated above flood threat, but significant sections of major transportation routes and many local roads traverse the flood plains of Skunk River. The preponderance of flood damages in the basin occurs to crops grown on flood plain lands and usually occur during the spring and summer months.

3. Existing flood problem. The more severe flood problems are along the upper reaches of Skunk River in Story, Polk, Jasper, and Marion Counties. Throughout the reach of river the flood plain is relatively wide, reaching its maximum width of two miles in Polk County. Downstream of this reach the valley is moderately wide throughout Mahaska County and abruptly reduces in width in Keokuk, Jefferson, and Henry Counties. The flood plain lands have been extensively developed for agricultural purposes. Of the total of 82,200 acres in the flood plain, 56,600 acres are used for crop and 13,100 acres are used for pasture. The major flood occurrences cause damages to farm areas, destroy crops, and disrupt traffic.

4. Scope of benefits. The principal effect of the proposed Ames Reservoir would be the reduction of flood damages in the Skunk River valley. The reservoir would reduce flood discharges in reaches extending downstream to the junction of North Skunk River. The reservoir would supplement low flows and provide water quality control and water supply benefits. Fish and wildlife conservation would be realized in downstream channels and in the reservoir area. The recreational areas of conservation parks would be large enough to attract visitors from the contiguous area and recreation benefits would be provided.

5. Study procedure. The annual flood control benefits were evaluated by the damage-frequency method, as the difference in annual flood damages with and without the proposed Ames Reservoir project operating. The reservoir was also credited with water quality control, water supply, fish and wildlife conservation and recreation benefits which would stem from use of the conservation storage to be provided. An alternate potential dam site was examined but was eliminated on the basis of economic considerations. For the site selected, benefit and cost studies were made of a dam and reservoir of varying flood control capacity to determine the scope of project development at which the greatest excess of benefits over costs was experienced.

SECTION II - FLOOD DAMAGE EVALUATION

6. Study reaches. To facilitate the economic studies in the areas investigated for this report, the Skunk River was divided into reaches as shown in Table A-1.

Table A-1

Limits of Reaches for Flood Damage Determination
Skunk River

Reach	From	To
1	Mouth	Confluence of North Skunk River, mile 93.1
2	Mouth of North Skunk River, mile 93.1	Mouth of Indian Creek, mile 179.5
3A	Mouth of Indian Creek, mile 179.5	Jasper-Polk County line mile 187.5
3B	Jasper-Polk County line, mile 187.5	Polk-Story County line, mile 202.1
4	Polk-Story County line, mile 202.1	Ames dam site, mile 220.6

7. Past floods and damages. Detailed damage surveys were made by personnel of the Rock Island District, Corps of Engineers, in 1947 and 1948 for those reaches listed in table A-1. Essentially, all owners or tenants whose property was known to have been affected by floods were interviewed. These surveys covered floods which occurred in August 1943, May 1944, May 1945, June 1946, and June 1947. Complete information was obtained for each of these floods concerning the extent and use of the areas inundated, the productive value of the overflowed lands, the extent of each type of crop wholly or partially damaged, the extent and type of crops replanted following the flood, and the value of the property lost. In addition to the foregoing, reconnaissance surveys were made of those flood plain areas along the Skunk River upstream from Ames. Inasmuch as the floods of May 1944 and June 1947 caused serious damages in the aforementioned reaches, considerable information was made available to the damage surveyors for subsequent use in estimating average annual flood damages. The acreage

flooded and the extent of crop and property damages incurred along the Skunk River from its mouth to the Ames dam site (mile 220.6) during the floods of May 1944 and June 1947 are summarized by reaches in tables A-2 and A-3, respectively. The largest flood of record occurred in April 1960 in the lower reaches of Skunk River and caused property damages estimated at $630,000. Flooding in all reaches has occurred in July 1961 and in May 1963. Damages for these latter floods have not been evaluated. For purposes of this investigation, Corps of Engineers personnel visited the county conservationist, Soil Conservation Service, in each county along the Skunk River to obtain information on his estimate of present crop distribution and yields of Skunk River flood plain lands. The data thus obtained were correlated with data previously collected and revised where necessary in order to reflect current development conditions.

Table A-2A

Estimated Damages - Flood of May 1944 - Skunk River, Iowa

Reach	From (mile)	To (mile)	Total area inundated (acres)	Cultivated and pasture area inundated (acres)	Crop and pasture damage	Property damage	Total damage
1	0	93.1	16,333	13,817	$ 768,087	$116,000	$ 884,087
2	93.1	179.5	35,671	29,235	1,471,351	235,000	1,706,351
3A	179.5	187.5	5,157	4,564	241,369	26,000	267,369
3B	187.5	202.1	15,353	14,776	788,705	285,000	1,073,705
4	202.1	220.6	7,863	7,479	362,170	187,000	549,170
Totals			80,377	69,871	$3,631,682	$849,000	$4,480,682

Table A-2B

Estimated Damages - Flood of June 1947 - Skunk River, Iowa

Reach	From (mile)	To (mile)	Total area inundated (acres)	Cultivated and pasture area inundated (acres)	Crop and pasture damage	Property damage	Total damage
1	0	93.1	15,184	12,688	$ 744,495	$ 78,000	$ 822,495
2	93.1	179.5	34,769	28,348	1,484,407	70,000	1,554,407
3A	179.5	187.5	5,057	4,464	288,676	11,000	239,676
3B	187.5	202.1	15,227	14,650	709,649	160,000	869,649
4	202.1	220.6	7,794	7,410	341,795	50,000	391,795
Totals			78,031	67,560	$3,509,022	$369,000	$3,878,022

SECTION III - AVERAGE ANNUAL DAMAGES

8. Average annual crop and property evaluations. The information obtained by means of field surveys was supplemented by high-water profiles, topographic maps, aerial photographs, and stream-flow data available in the files of the Corps of Engineers and other interested agencies. From this basic material average annual flood damages were computed for each reach listed in table A-1 on the Skunk River. The procedure followed in computing these average annual damages is illustrated on plate A-1 in graphs A and B for crop damages and for rural property damages in reach 4.

a. Average annual crop damages, reach 4.

(1) An index station was selected at the U. S. Geological Survey-Corps of Engineers stream-gaging station located at Ames, below Squaw Creek, and damages within the reach were related to the stage, as described in step a.(3). The rating curve for the gage is shown on plate C-12.

(2) On plate C-8 are shown discharge-frequency curves for the Skunk River at Ames, below Squaw Creek.

(3) The results of the damage surveys indicated that the periods of inundation from Skunk River floods which occur during the crop-growing season, 1 May through 15 October, are usually of such duration as totally to destroy most of the crops affected. It was also indicated that extensive crop replanting of damaged fields was practiced following those floods which occur in May or early June. By introducing the monetary value of the actual crop loss for the floods covered by the damage surveys, the graph of stage at the gaging station versus crop damage shown on graph A was derived. The value of these losses is based on the average prices received by farmers for the various crops as of November 1964 and on the productivity value of lands in the Skunk River valley. These are shown in the following tabulation.

Type of crop	Average(1) yield per acre	Unit(2) price	Gross cash yield	Production cost per acre	Net cash yield per acre
Corn	85 bu.	$ 1.00	$85.00	$ 45.84	$ 39.16
Soybeans	30 bu.	2.55	76.50	28.28	48.22
Wheat	30 bu.	1.94	58.20	24.20	34.00
Oats	50 bu.	0.66	33.00	21.41	11.59
Alfalfa	2.5 ton	19.50	48.75	27.37	21.38
Clover	1 ton hay 1 bu.seed	17.17 10.33	27.50	21.42	6.08
M. hay	1.5 ton	18.67	28.00	14.94	13.06
Pasture	1 acre = 200 lbs. in 5 mo.	20.66 cwt.	41.32	2.72	38.60
Average values for flood plain based on crop distribution - a typical acre					37.61

(1) Average yields experienced on bottom land farms.

(2) From "Agricultural prices", U. S. Department of Agriculture. Statistical Reporting Service, Crop Reporting Board, Washington, D. C., average prices received November 1964, State of Iowa

(4) From the above chain of relations, i.e., stage versus discharge, discharge versus frequency (summer season floods, 1 May through 15 October), and stage versus crop damage, the graph of crop damage versus frequency (expressed in percent chance of occurrence) shown in graph B was derived. The average annual crop damage was then determined by computing the mean ordinate of this graph for the 100 percent abscissa.

9. Summary and comparison of average annual flood losses. A summary of the average annual crop and property damages for the reaches listed in paragraph 6 of this appendix is presented in table A-3.

Table A-3

Average Annual Flood Damages, Skunk River

Reach	Crop	Property	Total
1	$ 296,200	$ 45,200	$ 341,400
2	517,400	37,000	554,400
3A	59,800	2,000	61,800
3B	165,100	93,000	258,100
4	92,800	49,000	141,800
	$1,131,300	$ 226,200	$1,357,500

The average annual damages for the four reaches of main Skunk River are 83.5 percent crop and 16.5 percent property damages. The annual flood losses range from $12.00 to $20.50 per acre in the various study reaches, and the average is $16.56 per acre for all reaches. The annual crop losses average about $13.80 per acre for all reaches. The reasonableness of the average crop loss values was tested by a comparison of land values. Land sales are too infrequent to provide a reliable basis for a land charge, and most rentals are on share basis, so cash rentals are also inadequate. However, the theoretical land charges for the major crop types computed as the difference between gross income and all costs except land charge would average approximately $22.28. If $5.00 per acre is deducted for taxes the remaining $17.28 would support an average land value of $346 per acre if capitalized at 5 percent. This value appears reasonable for an average price of flood plain lands which are subject, as are those in the Skunk River valley, to frequent overflow. Although no data are available on the value of flood-free Skunk River bottom lands, improved essentially flood-free land in the Polk county reach (not flooded since 1947) have recently brought as much as $350 to $375 per acre. Thus, in the light of indicated land values, the estimates of agricultural damages appear to be within reasonable limits.

SECTION IV - ANNUAL FLOOD DAMAGE REDUCTIONS

10. Average annual flood control benefits. The average annual flood damage prevention benefits evaluated for this report comprise the estimated annual benefits which would accrue as a result of implementation of the reservoir plan studied. The procedures used in the benefit computations are identical to those discussed in paragraph 4, except that the damage-frequency relationship for the various reaches were plotted using the modified discharge-frequency data resulting from reservoir operation. Benefit determinations for reach 4 are shown on plate A-2. The results of the benefit studies for each of the reaches studied are shown in table A-4.

Table A-4

Average Annual Flood Control Benefits
Ames Reservoir System
Skunk River

Reach	Crop	Property	Total
1	$ 0	$ 0	$ 0
2	60,400	10,800	71,200
3A	8,000	2,000	10,000
3B	114,000	74,200	188,200
4	59,200	40,800	100,000
	$ 241,600	$ 127,800	$ 369,400

SECTION V - WATER CONSERVATION BENEFITS

11. Water conservation needs. Water conservation needs exist in the basin for water quality, municipal and industrial water supply, and for improvement of the fish and wildlife habitat, as well as for recreational development. Studies to determine the needs of irrigation and hydroelectric power have shown that present and future demands for reservoir storage for such purposes are of limited value.

12. Water quality control. A study made by the U. S. Public Health Service has concluded that conditions at Ames, Iowa, as projected will be the major source of treated wastes discharged to the main stem of Skunk River. The study indicated that a flow of about 68 c.f.s. past the city of Ames would be required to adequately take care of the increased pollution load resulting from projected growth conditions at Ames. The storage requirements for releases for quality control in the main stem immediately below Ames has been determined by the U. S. Public Health Service to be 25,000 acre-feet. The first year of need is estimated to be 1970 (for purposes of this report the Service considered the year 1970 to be present year for first year of reservoir operation). Based on the annual cost of an alternate single-purpose reservoir to provide the quality control needs, the Public Health Service computed the annual value of storage for low flow augmentation to be $200,000. As discussed in the main report, a storage allocation of 25,000 acre-feet is to be provided initially for dual purposes of water quality control and for water supply, inasmuch as the need for the latter storage will be the year 2020. Presuming that a reserve for storage for water supply will be needed 50 years in the future, the water quality control storage will be reduced to 15,000 acre-feet. The annual benefits for water quality control therefore will be $200,000 for the first 50-year period and $120,000 (15/25 x $200,000) for the second 50-year period of the 100-year project life. The equivalent annual benefit over the life of the project is computed to be $186,000, computed as follows, using 3-1/8 percent interest.

(1) Years 1 to 50 annual benefit - $200,000
Capital value of $200,000 annually =
$200,000 x 25.13008 = $5,026,016

(2) Years 51-100 annual benefit - $120,000
Capital value of $120,000 annually =
$120,000 x 25.13008 = $3,015,610
Present value = $3,015,610 x 0.21469 =
$647,421 (discounted capital value)

Amortize the values of (1) and (2) over
100-year life: ($5,026,016 + $647,421)
x 0.03276 = $185,900, say 186,000, equivalent annual value

13. Water supply. The U. S. Public Health Service concluded that the watershed has adequate ground water supplies of acceptable quality to meet the needs of municipal and industrial water requirements through the year 2060, with the exception of future needs for Ames, Iowa. The demand for municipal and industrial water requirements of Ames is projected to reach 20 m.g.d. by 2060. It is estimated that 10 m.g.d. can be obtained from ground water sources. The city's demand is expected to increase to 10 m.g.d. by the year 2020. The U. S. Public Health Service estimated that a flow of 10 c.f.s. would be required to satisfy these needs, and the draft on the available storage would be 10,000 acre-feet. Using the annual charges of an alternate single-purpose reservoir, discounted to present worth and averaged over the 100-year project life, the Public Health Service estimated the annual benefits for water supply to be $18,000 annually.

14. Fish and wildlife. The U. S. Fish and Wildlife Service furnished estimates of the benefits which would accrue from reservoir operation. These estimates were based on the establishment of a permanent pool in the reservoir of 630 acres. The Service states that fishery resources in the reservoir area will be lost because of inundation of the stream channel by the permanent pool. However, such losses will be offset by the heavily used reservoir and tailwater fishery. They evaluate the net gains to the fishery in the amount of $29,600 annually for the 630-acre pool. The Service states that construction of Ames Reservoir will result in complete loss of wildlife habitat due to inundation of lands by the permanent pool. They do not evaluate the extent of the wildlife losses. The Service also states that losses to wildlife will occur to downstream areas. On the other hand, increased flows for augmenting low-flow conditions in downstream areas will be a gain to the

fishery component. These values are not evaluated in the report of the Service. Accordingly, for purposes of this report, it is considered that the gains to downstream fishery will offset losses to wildlife, and the Ames Reservoir project has been credited with an overall fish and wildlife benefit, incidental to the establishment of the permanent pool, of $29,600. The surface area of the storage maintained in Ames Reservoir for conservation needs (33,400 acre-feet) will be considerably in excess of the 630 acres evaluated for fish and wildlife benefits. However, because this conservation storage will be used to serve the needs of downstream low flow augmentation, the 25,000 acre-foot pool will be subject to drawdown. Accordingly, the fish and wildlife benefits accredited to the Ames Reservoir are considered to be conservative.

15. Recreation. The Regional Office of the Bureau of Outdoor Recreation developed a visitor-day value applicable to the recreational potential of the Ames Reservoir project. The Bureau estimated the following visitation and project benefits.

Period	Annual visitation	Annual benefit (1)
Initial (years 1-5)	110,000	$ 82,500
Ultimate (years 6-35)	180,000	135,000
(years 36-100)	180,000	135,000

(1) The value of 75¢ per visitor day was used by the Bureau of Outdoor Recreation to evaluate benefits.

It will be noted that the above benefits will accrue to the project in future years in varying amounts. It is therefore necessary to compute equivalent annual benefits over the project life, which were determined to be $123,300. The following method was used for this determination, using 3-1/8 percent interest rate.

(1) Years 1 to 5 annual benefit - $82,500

Capital value of $82,500 annually =

$82,500 x 4.56341[1] = $376,481

Present value = $376,481 x 0.96970[2] = $365,074

(2) Years 6 to 35 annual benefit - $135,000

Capital value of $135,000, years 6-35 (30 years) = $135,000 x 19.28750[3] = $2,603,812 capital value for 30 years with no delay

Present value = $2,603,812 x 0.83141[4] = $2,164,835 (discounted capital value)

(3) Capital value of $135,000 annually, years 36-100, = $135,000 x 27.66995[5] = $3,735,443 capital value for 65 years with no delay

Present value = $3,735,443 x 0.33029[6] = $1,233,779 (discounted capital value)

Amortize the total of discounted capital value of (1), (2), and (3): $365,074 + $2,164,835 + $1,233,779 = $3,763,688 x 0.03276[7] = $123,298, say $123,300 average annual equivalent benefit over project life.

(1) Present value of annuity of $1 per year for 5 years.

(2) Present value of $1, one year hence.

(3) Present value of annuity of $1 per year for 30 years.

(4) Present value of $1, six years hence.

(5) Present value of an annuity of $1 per year for 65 years.

(6) Present value of $1, thirty-six years hence.

(7) Capital recovery factor - 100 years.

In their report the Bureau of Outdoor Recreation estimated the cost of recreation facilities at $368,000 for the period 1 through 5 years and increased to $621,000 for the period 6 through 35 years. Assuming an annual amount of these expenditures would be $73,600 ($368,000/5) and $8,450 ($621,000 - $368,000/30). The present value of these expenditures for recreation facilities would amount to $475,600 computed as follows:

(1) Annual amount expended years 1-5 - $73,600
Present value = $73,600 x 4.56341 = $335,866

(2) Annual amount expended years 6-35 - $8,450
Present value = $8,450 x 19.28750 x 0.85739 = $139,736

Summation of (1) and (2) above = $475,600

SECTION VI - SUMMARY OF ANNUAL PROJECT BENEFITS

16. Total project benefits. Operation of Ames multiple-purpose reservoir would provide benefits in the amounts shown in the following tabulation according to the purpose served and evaluated as discussed hereinabove.

Purpose	Estimated annual benefit
Flood control	$369,400
Water quality control	186,000
Water supply	18,000
Fish and wildlife	29,600
Recreation	123,300
Total project benefits	$726,300

SECTION VII - PROJECT FORMULATION

17. Determination of project scope. Studies were made of Ames Reservoir serving the single purpose needs of flood control for determination of the optimum capacity that would provide the maximum excess of benefits over costs. Estimates of total project costs were prepared for a range in reservoir capacities based on fixed spillway crest elevations at two foot intervals between the limits of elevation 957.5 through elevation 968.0. The gross storage capacity at full pool for the above elevations would range from 56,000 acre-feet to 94,000 acre-feet, respectively. Net storage for single purpose flood control storage would amount to 47,600 acre-feet and 85,600 acre-feet respectively, when deducting 8,400 acre-feet reserved for sedimentation. Using the net flood control capacity that would be available for the corresponding crest elevations used in this study, modified discharge frequency relationships were prepared for the index stations of flood damage reaches, for purposes of flood control benefit determinations. Table A-5 shows pertinent data on project costs, annual charges and annual flood control benefits resulting from this study.

18. A plot of the cost-benefit data of Table A-5 is shown on Plate A-2. The plot of flood control benefits versus annual charges shows that the point of maximum net benefits is reached at about elevation 968. Benefits from water quality control, water supply, fish and wildlife and recreation, which total $356,900 were added to the flood control benefits shown in Table A-5 for total project benefits. A plot of total benefits versus annual charges is shown also on Plate A-2. This relationship also indicates that the optimum reservoir capacity is reached at about elevation 968.

19. Storage allocation. Based upon results of the above study, it was indicated that storage for flood control in Ames Reservoir could be economically established at elevation 968. However, when considering storage requirements to satisfy the needs of water quality control, 25,000 acre-feet, and needs of water supply, 10,000 acre-feet, as set up by the U. S. Public Health Service, physical limitations of the reservoir made it impracticable to superimpose such storage on the 94,000 acre-feet gross storage of sedimentation and flood control. Accordingly, allocation of flood control storage was established at 60,600, 25,000 acre-feet for water quality control and water supply (the latter storage requirement is not needed until year 2020) and 8,400 acre-feet for the sedimentation reserve. Appendix C discusses the need for water storage reserve for mitigating losses due to evaporation, transpiration and ice cover in order to assure delivery of desired minimum low flows at Ames. Because of limited storage available in the reservoir, the infrequent need for such reserve and the relative magnitude of flood control benefit, storage allocated to water quality control and water supply as a part of this study was held at 25,000 acre-feet. In the basin wide study to be made at a later date, other reservoirs will be studied and allocations of storage in these reservoirs for water quality control and water supply may be desirable. It is to be noted that benefits accruing to the project from fish and wildlife and recreation will be provided primarily by establishment of the 8,400 acre-feet sedimentation pool. Benefits were conservatively estimated for purposes of fish and wildlife recreation. However, under most conditions, these benefits will be greater because the surface area will be considerably in excess of the 630 acres because of the 25,000 acre-foot storage pool for water quality control and water supply needs. However, this storage reserve will be subject to drawdown for low flow augmentation purposes.

TABLE A-5

AMES RESERVOIR - FIXED SPILLWAY COSTS AND FLOOD CONTROL BENEFITS

Spillway crest elevation Ft. m.s.l.	Net flood control capacity Acre-feet	Project first cost	Annual charges	Annual flood control benefits	Excess of benefits over costs
957.5	47,600	$8,016,000	$297,900	$300,000	$ 2,100
960.0	55,600	8,245,000	307,600	350,000	42,400
962.0	61,600	8,416,000	314,800	388,000	73,200
964.0	69,600	8,776,000	329,000	430,000	101,000
966.0	76,600	9,166,000	344,100	469,000	124,900
968.0	85,600	9,644,000	362,400	491,000	138,000
970.0	93,600	(1)	(1)		

(1) Costs not determined - it is considered that additional remedial features at this elevation would increase total project costs in excess of the benefits to be obtained.

SECTION VIII - COST ALLOCATION

20. Purpose and method. Preliminary cost allocations were made to distribute the project costs and annual operation and maintenance costs among the several purposes to be served by the Ames Reservoir. Cost data used for these determinations were based on project costs for a dam with a fixed spillway. Cost allocations by the Separable Costs-Remaining Benefits method, wherein separable costs are charged to the respective purposes and the joint-use costs are distributed so that each purpose shares equitably in benefits of multiple-purpose construction and operation. Separable costs were computed as the difference between the cost of the multiple-purpose reservoir with and without the purpose in question. Inasmuch as incremental storage for either water supply or recreation was not provided in Ames Reservoir the cost allocation procedure does not provide for dual separable costs for these purposes.

21. Alternative projects. A cost curve, showing project costs versus storage capacity, was developed for the Ames Reservoir, based on data shown in Table A-5. This curve was used for estimating the cost of a single-purpose alternative reservoir, Table A-6, and Separable Costs, Table A-7.

22. Cost allocation analysis. The only specific cost applicable to the Ames Reservoir study is for recreation facilities and improvements. The allocation of cost to project purposes by the Separable Cost - Remaining Benefit method is shown in Table A-8. The table was prepared using cost data of a dam with a fixed spillway. The cost allocations of the recommended project, a dam with gated spillway, were derived by apportionment, as shown at the end of Table A-8.

23. Cost apportionment.

a. Water supply. Inasmuch as water supply needs are not required until the year 2020, the portion of costs of Ames Reservoir, in the amount of $243,000 (Table A-8), to be borne by local interests are not required at start of project construction. As discussed in the main report, allocation of storage for water supply will not require modification of the dam.

b. Recreation. Local participation in the recreation facilities would not be required in accordance with the cost-sharing criteria of H.R. 9032. Table A-9, illustrates the procedure for computation of Federal and non-Federal shares of costs for recreation.

TABLE A-6

AMES RESERVOIR - MULTIPLE PURPOSE AND SINGLE PURPOSE PROJECT COSTS AND BENEFITS
COST ALLOCATION STUDIES

Item	Multiple purpose	Flood control	Water quality control	Water supply	Fish and wildlife	Recreation
1. First cost	$9,168,000	$7,944,400	$6,400,000	$5,300,000	$ 581,000	$ 581,000
2. Project investment						
Recreation development	475,600		-	-	-	475,600
Interest during construction	301,300	248,300	200,000	165,600	18,200	33,000
Total first cost	$9,944,900	$8,192,700	$6,600,000	$5,465,600	$ 589,200	$1,089,600
3. Annual financial cost						
Interest	$ 310,800	$ 256,000	$ 206,250	$ 170,800	$ 18,400	$ 34,100
Amortization	15,100	12,400	9,960	8,300	900	1,600
Maintenance & Operation	10,000	10,000	10,000	8,000	6,000	6,000
Total annual charges	$ 335,900	$ 278,400	$ 226,210	$ 187,100	$ 25,300	$ 41,700

4. Annual benefits	
Flood control	$ 369,400
Water quality control	186,000
Water supply	18,000
Fish and wildlife	29,600
Recreation	123,300
Total annual benefits	$ 726,300

TABLE A-7

AMES RESERVOIR - COST ALLOCATION STUDIES

Item	Alternative Project With One Purpose Omitted						Separable Costs				
	Multiple Purpose	Flood Control Omitted	Water Quality Omitted	Water Supply Omitted	Fish & Wildlife Omitted	Recreation Omitted	Flood Control	Water Quality Control	Water Supply	Fish & Wildlife	Recreation
Storage - Acre-feet	94,000	33,400	69,000	94,000	94,000	94,000					
First Cost, Reservoir	$9,168,000	$6,400,000	$7,944,400	$9,168,000	$9,168,000	$9,168,000					
Recreation Facilities	475,600	475,600	475,600	475,600	475,600	-					
Project Investment	$9,643,000	$6,875,600	$8,420,000	$9,643,600	$9,643,600	$9,168,000	$2,768,000	$1,223,600	$ 0	$ 0	$ 475,600
Interest during Constr.	301,300	214,900	263,100	301,300	301,300	286,500	86,400	38,200	0	0	14,800
Total Project Investment	$9,944,900	$7,090,500	$8,683,100	$9,944,900	$9,944,900	$9,454,500	$2,854,400	$1,261,800	$ 0	$ 0	$ 490,400
Annual Costs:											
Interest	$ 310,800	$ 221,600	$ 271,300	$ 310,800	$ 310,800	$ 295,500	$ 89,300	$ 39,500	$ 0	$ 0	$ 15,300
Amortization	15,100	10,700	13,100	15,100	15,100	14,300	4,300	2,000	0	0	800
Maintenance & Operation	10,000	10,000	10,000	10,000	10,000	10,000	-	-	-	-	-
Total Annual Costs	$ 335,900	$ 242,300	$ 294,400	$ 335,900	$ 335,900	$ 319,800	$ 93,600	$ 41,500	$ 0	$ 0	$ 16,100
Annual Benefits:											
Flood Control	$ 369,400	$ -	$ 369,400	$ 369,400	$ 369,400	$ 369,400					
Water Quality Control	186,000	186,000	-	186,000	186,000	186,000					
Water Supply	18,000	18,000	18,000	-	18,000	18,000					
Fish & Wildlife	29,600	29,600	29,600	29,600	-	29,600					
Recreation	123,300	123,300	123,300	123,300	123,300	-					
Total Annual Benefits	$ 726,300	$ 356,900	$ 540,300	$ 708,300	$ 696,700	$ 603,000					
Net Benefits	+$ 391,600	+$ 114,600	+$ 245,900	+$ 372,400	+$ 360,800	+$ 283,200					

TABLE A-8

AMES RESERVOIR - COST ALLOCATION BY SEPARABLE COST - REMAINING BENEFITS ALLOCATIONS OF COSTS TO PROJECT PURPOSES

Item	Flood Control	Water Quality Control	Water Supply	Fish and Wildlife	Recreation	Total
1. Benefits	$ 369,400	$ 186,000	$ 18,000	$ 29,600	$ 123,300	$ 726,300
2. Alternative Single Purpose Annual Costs	278,400	226,200	187,100	25,300	41,700	758,700
3. Benefits Limited by Alternative Cost (lesser of items 1 and 2)	278,400	186,000	18,000	25,300	41,700	549,400
4. Separable Costs	93,600	41,500	0	0	16,100	151,200
5. Remaining Benefits (items 3-4)	184,800	144,500	18,000	25,300	25,600	398,200
6. Percentage of item 5	46.4	36.4	4.5	6.3	6.4	100.0
7. Joint Costs ($335,900-$151,200) x item 6	85,700	67,200	8,400	11,600	11,800	184,700
8. Total Allocations (items 4 + 7)	179,300	108,700	8,400	11,600	27,900	335,900
9. Total M&O Costs, in proportion to 6	4,640	3,640	450	630	640	10,000
10. Net Annual Costs (items 8-9)	174,660	105,060	7,950	10,970	27,260	325,900
11. Project Investment (item 10 ÷ 0.03276)	5,329,800	3,206,000	242,600	334,700	831,800	9,944,900
12. Project First Cost (item 11 ÷ 1.03125)	5,168,400	3,108,800	235,300	324,500	806,600	9,643,600
13. Approximate Benefit-Cost Ratio (item 1 ÷ 8)	2.1	1.7	2.3	2.6	4.4	2.1
14. Recommended Project First Cost Allocation in Proportion to Item 12	5,429,700	3,261,900	243,100	344,400	850,900	10,130,000
Use	5,430,000	3,262,000	243,000	344,000	851,000	

TABLE A-9

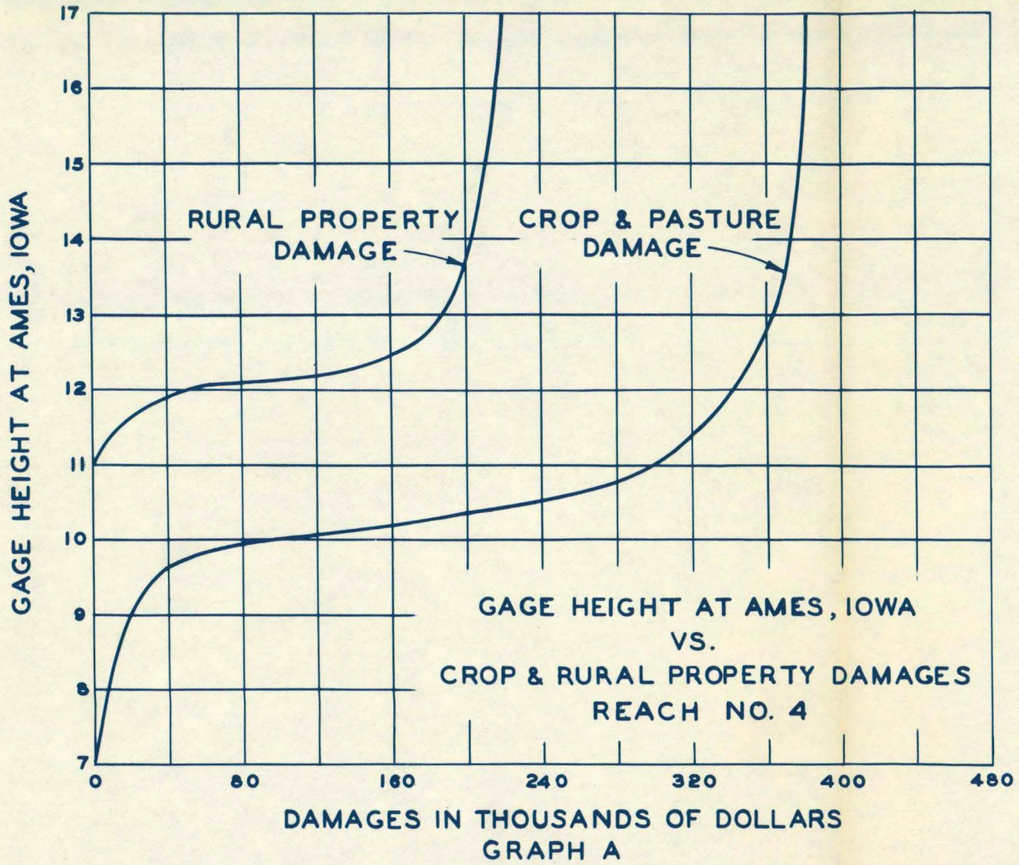
COMPUTATION OF THE FEDERAL AND NON-FEDERAL SHARES OF COSTS FOR RECREATION

	Ames Reservoir Project	
a. Joint-use costs (lands and facilities)		
(1) Total initial construction costs	$10,130,000	
(2) Total specific lands and facilities	475,600	
(3) Total joint-use lands and facilities	$ 9,654,400	
b. Allocated construction costs of lands and facilities for recreation and fish and wildlife enhancement.		
(1) Specific costs	475,600	
(2) Joint costs	368,000	(1)
(3) Other costs (separable less specific costs)	0	
(4) Total	$ 843,600	
c. Cost-sharing under H.R. 9032		
(1) Non-reimbursable (Federal)		
(a) Specific costs, item b(1)	475,600	
(b) Joint costs, item b(2)	368,000	
(c) Limit on joint costs under H.R. 9032	2,420,000	(2)
(d) Other costs, item b(3)	0	
(e) Limit on other costs under H.R. 9032 (0.25x$9,654,400)	2,420,000	
(f) Federal costs (non-reimbursable)	$ 843,600	
(2) Reimbursable (non-Federal)		
(a) Excess of joint costs over limit	None	
(b) Excess of other costs over limit	None	
(c) Non-Federal costs (reimbursable)	None	

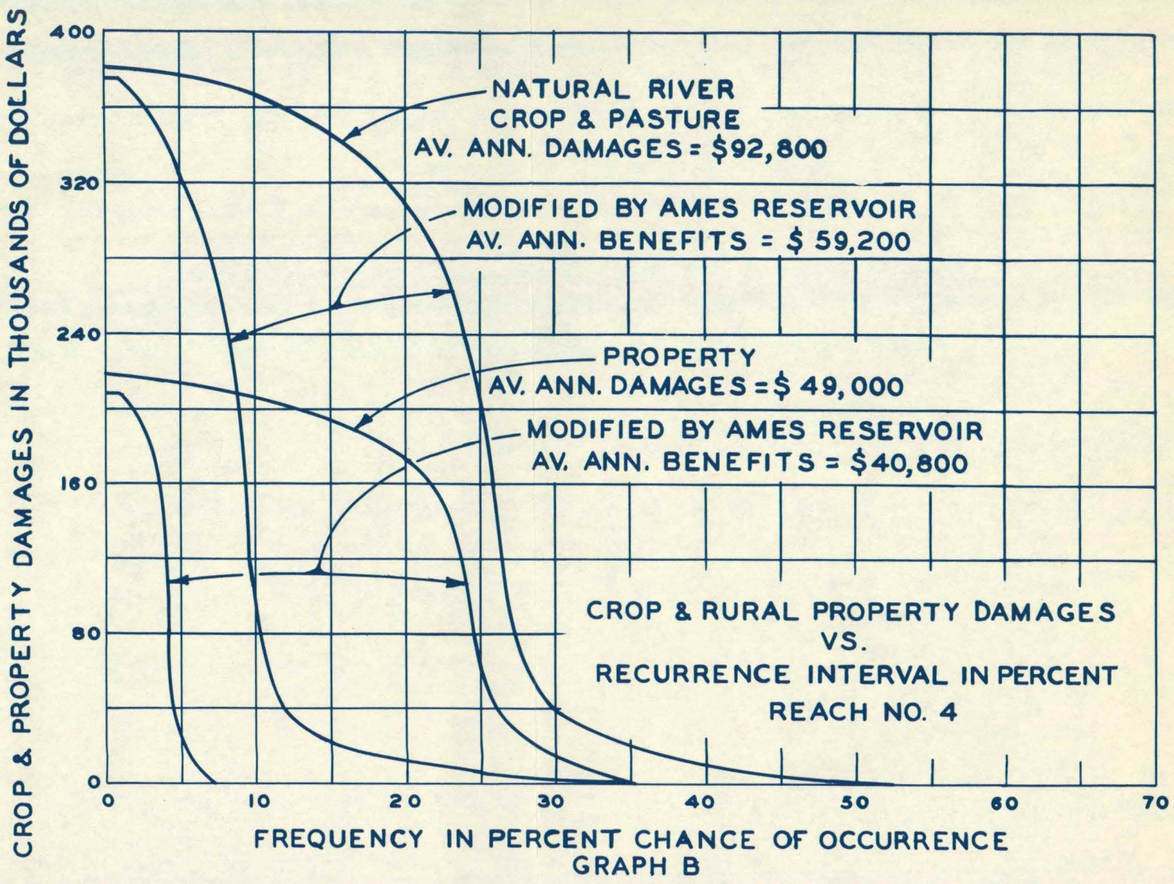
(1) ($11,800 (line 7, Table A-8 ÷ $27,260 (line 10 Table A-8)

$851,000 (line 14, Table A-8)

(2) 25% of $9,654,000



GRAPH A



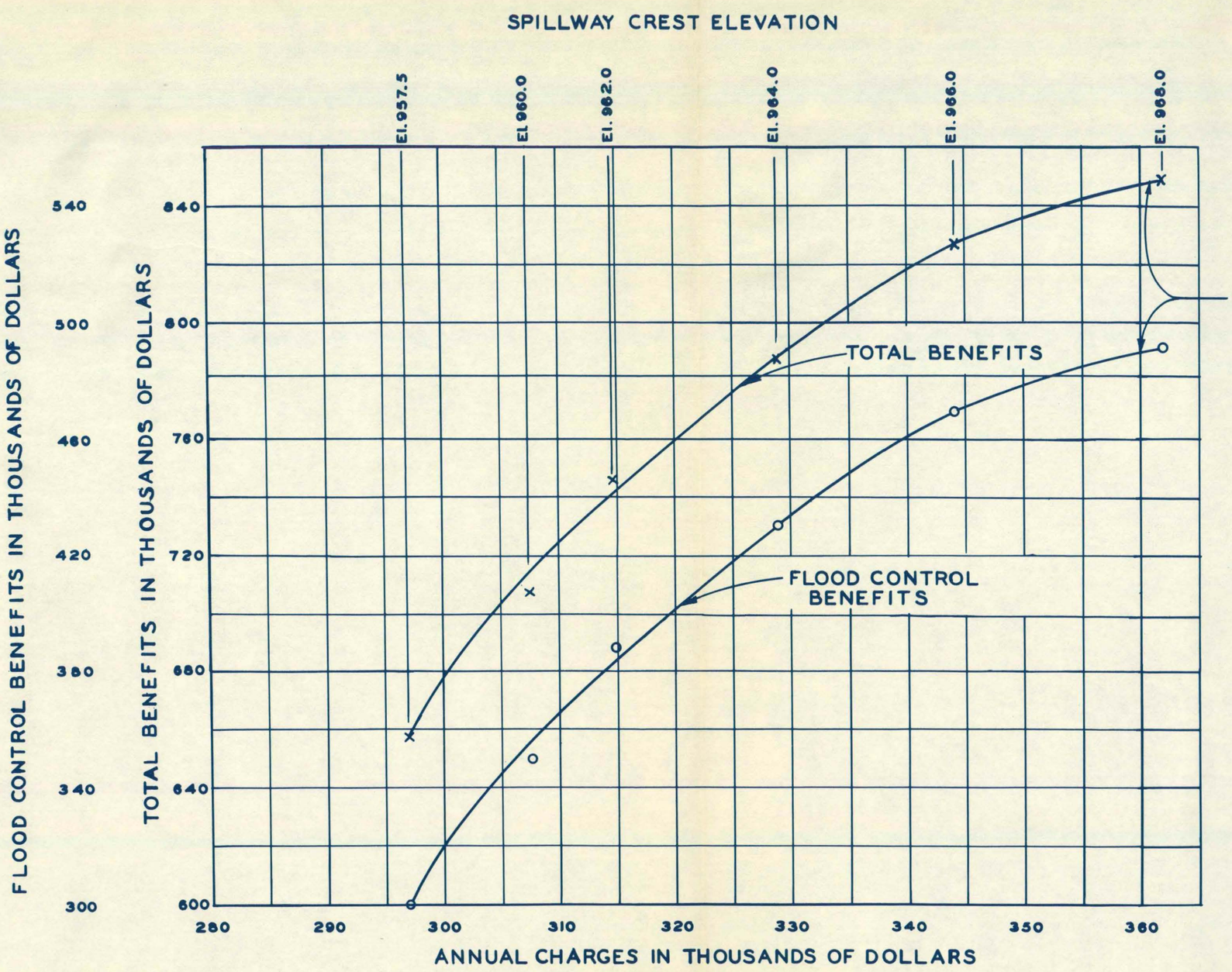
GRAPH B

NOTES:

1. THE REFERENCE GAGING STATION IS THE U.S.G.S. GAGE AT AMES, IOWA, BELOW SQUAW CREEK.
2. THE RATING CURVE USED IN THIS ANALYSIS IS SHOWN ON PLATE C-8.
3. DISCHARGE - FREQUENCY CURVE DATA USED IN THIS ANALYSIS ARE SHOWN ON PLATE C-12.
4. CROP AND RURAL PROPERTY DAMAGES ARE BASED ON 1964 PRICE LEVELS.

SKUNK RIVER, IOWA
INTERIM SURVEY REPORT
GRAPHS - ECONOMIC ANALYSIS

CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
DECEMBER 1964



OPTIMUM SIZE OF DEVELOPMENT	
TOTAL STORAGE-ACRE FEET	94,000
FLOOD CONTROL	60,600
SEDIMENTATION RESERVE	8,400
WATER QUALITY CONTROL— WATER SUPPLY — DUAL USE	25,000
TOTAL AVERAGE BENEFITS	$848,500
AVERAGE ANNUAL CHARGES	$362,400
NET ANNUAL BENEFITS	$486,100
B/C RATIO	2.3 : 1.0

AMES RESERVOIR
SKUNK RIVER, IOWA
SINGLE PURPOSE FLOOD CONTROL
AND MULTIPLE PURPOSE ANALYSIS

CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
DECEMBER 1964

AMES RESERVOIR - SKUNK RIVER, IOWA

APPENDIX B

DETAILED ESTIMATE OF COST

U. S. Army Engineer District, Rock Island
Corps of Engineers
Clock Tower Building
Rock Island, Illinois

APPENDIX B

DETAILED ESTIMATE OF COST

AMES RESERVOIR - SKUNK RIVER, IOWA

1. General. Unit costs used in this estimate for the proposed Ames Reservoir are based on November 1964 prices. Unit costs of construction items are based upon fair and reasonable costs, including overhead and profit; the work to be done by a capable and well-equipped contractor. No consultations regarding costs were held with contractors or other agencies, but unit prices were compared with current bids on work of similar nature. The total costs of the project contain a reasonable allowance for engineering, contingencies, and overhead.

2. A routing of Interstate Highway 35 through the proposed reservoir, as shown on Plate 2, necessitated a determination of responsibility for increased highway costs due to reservoir construction. The division of responsibility between the Interstate project and the reservoir project is shown in this cost estimate and is based on an estimate furnished by the Iowa State Highway Commission as adapted to the proposed reservoir project.

DETAILED ESTIMATE OF COST

Item	Quantity	Unit	Unit price	Amount
DAM EMBANKMENT				
Fill				
From spillway approach channel excavation	447,526	c.y.	$ 0.15	$ 67,129
From spillway excavation	58,028	c.y.	0.15	8,705
From inspection trench	4,800	c.y.	0.15	720
Impervious blanket	25,000	c.y.	0.35	8,750
Pervious borrow	105,157	c.y.	1.00	105,157
Stripping	18,318	c.y.	0.40	7,327
Inspection trench	4,861	c.y.	0.50	2,431
Riprap	17,142	c.y.	9.00	154,278
Gravel	6,077	c.y.	6.00	36,462
Gravel roadway	2,800	s.y.	1.75	4,900
Seeding	3.5	acre	300.00	1,050
Topsoil	5,571	c.y.	0.60	3,343
Toe drainage				
Collector ditch excavation	497	c.y.	1.50	746
Relief wells (33' deep)	14	each	3,300.00	46,200
Miscellaneous items		sum		25,000
		Sub-total		$ 472,198
		Contingencies		94,402
		Total Dam Embankment		$ 566,600

DETAILED ESTIMATE OF COST

Item	Quantity	Unit	Unit price	Amount
SPILLWAY				
Excavation				
Channel, common	510,000	c.y.	$ 0.50	$ 255,000
Channel, rock	29,600	c.y.	5.00	148,000
*Gated spillway 5 gates 16'x40'; net opening = 200' - Gross length per gate = 48'. Cost includes gates, piers, sill and apron, service bridge and operating machinery	1	job	sum	800,000
Retaining walls				
Concrete	5,650	c.y.	60.00	339,000
Reinforcing steel	113,000	lbs.	0.20	22,600
Close-line drilling and broaching				
Retaining walls	4,800	s.f.	3.00	14,400
Cut-off walls	2,800	s.f.	3.00	8,400
			Sub-total	$1,587,400
			Contingencies	476,000
			Total Spillway Cost	$2,063,400

* Note: Cost for gated spillway section derived from cost summary of Dams 13, 14, and 17 on Mississippi River using applicable cost index for price increase from 1937 to 1964.

DETAILED ESTIMATE OF COST

Item	Quantity	Unit	Unit price	Amount
OUTLET WORKS				
Excavation				
Channel	2,776	c.y.	$ 0.50	$ 1,388
Common	11,184	c.y.	0.50	5,592
Structural	28	c.y.	3.50	98
Concrete				
Intake structure				
Footing slab	30	c.y.	40.00	1,200
Beams and columns	26	c.y.	75.00	1,950
Conduit	780	c.y.	75.00	58,500
Seepage collars	150	c.y.	75.00	11,250
Stilling basin				
Walls	393	c.y.	60.00	23,580
Slab	76	c.y.	40.00	3,040
Baffles	14	c.y.	75.00	1,050
End sill	11	c.y.	35.00	385
Control and gate structure	441	c.y.	60.00	26,460
Reinforcing steel	287,850	lbs	0.16	46,056
Sluice gates 48"x72" power operated	3	each	2,300.00	6,900
Handrail	250	l.f.	7.00	1,750
Grating steel	50	s.f.	3.50	175
Ladder rungs	85	each	2.00	170
Electric service	1	job	sum	500
Gage well equipment	1	job	sum	5,000
Conduit liners	13,200	lbs	0.50	6,600
Trash rack	1	job	sum	1,900
Backfill	6,985	c.y.	1.25	8,732
Cofferdam	1	job	sum	20,000
		Sub-total		$ 232,276
		Contingencies		46,724
		Total Outlet Structure		$ 279,000

DETAILED ESTIMATE OF COST

Item	Quantity	Unit	Unit price	Amount
MISCELLANEOUS				
Construction facilities			Sum	$ 18,000
Clearing dam site and conservation pool	500	acre	$ 250.00	125,000
Access roads			Sum	18,000
Landscaping			Sum	9,000
Sub-total				$ 170,000
Contingencies				30,000
Total - Miscellaneous				$ 200,000

DETAILED ESTIMATE OF COST

Item	Quantity	Unit	Unit price	Amount
REMEDIAL WORKS				
Road on Section 6/7 T84N, R23W Keigley Branch Bridge 260' long - 3 span				
2 Abutments				
Concrete	140	c.y.	$ 65.00	$ 9,100
Reinforcing steel	10,000	lb.	0.16	1,600
Excavation, common	160	c.y.	3.50	560
Backfill	90	c.y.	4.50	405
Piling, timber (treated)	1,200	l.f.	4.00	4,800
2 Piers				
Concrete	260	c.y.	65.00	16,900
Reinforcing steel	36,400	lb.	0.16	5,824
Piling, timber (treated)	1,450	l.f.	4.00	5,800
Excavation, common	780	c.y.	3.50	2,730
Backfill	660	c.y.	4.50	2,970
Cofferdam and dewater	2	each	10,000.00	20,000
1 Superstructure				
Concrete	200	c.y.	80.00	16,000
Reinforcing steel	46,000	lb.	0.16	7,360
Guard rail	520	l.f.	7.00	3,640
Structural steel A373	157,170	lb.	0.22	34,577
Structural steel A441	89,076	lb.	0.25	22,269
Bridge shoes	8,588	lb.	0.60	5,153
Skunk River Bridge 380' long - 5 span				
2 Abutments				
Concrete	140	c.y.	65.00	9,100
Reinforcing steel	10,000	lb.	0.16	1,600
Piling, timber (treated)	1,200	l.f.	4.00	4,800
Excavation, common	160	c.y.	3.50	560
Backfill	90	c.y.	4.50	405

DETAILED ESTIMATE OF COST

Item	Quantity	Unit	Unit price	Amount
REMEDIAL WORKS (continued)				
4 Piers				
Concrete	510	c.y.	$ 65.00	$ 33,150
Reinforcing steel	72,000	lb.	0.16	11,520
Piling, timber (treated)	3,000	l.f.	4.00	12,000
Excavation, common	1,560	c.y.	3.50	5,460
Backfill	1,320	c.y.	4.50	5,940
Cofferdam and dewater	2	each	10,000.00	20,000
1 Superstructure				
Concrete	292	c.y.	80.00	23,360
Reinforcing steel	67,160	lb.	0.16	10,746
Guard rail	760	l.f.	7.00	5,320
Structural steel A373	229,710	lb.	0.22	50,536
Structural steel A441	130,188	lb.	0.25	32,547
Bridge shoes	12,880	lb.	0.60	7,728
Excavation, common	21,780	c.y.	0.50	10,890
Embankment, fill	564,000	c.y.	0.75	423,000
Guard rail	2,800	l.f.	3.50	9,800
Gravel surfacing	2,000	c.y.	5.00	10,000
Stripping	11,750	c.y.	0.40	4,700
Seeding	7	acre	300.00	2,100
Riprap	17,000	c.y.	9.00	153,000
Sub-total				$1,007,950
Contingencies				201,350
Total - Cost of Remedial Work along Section 6/7				$1,209,300
Road along Section 30/31				
2 Abutments				
Concrete	140	c.y.	65.00	9,100
Reinforcing steel	10,000	lb.	0.16	1,600
Piling, timber (treated)	1,200	l.f.	4.00	4,800
Excavation, common	160	c.y.	3.50	560
Backfill	90	c.y.	4.50	405

DETAILED ESTIMATE OF COST

Item	Quantity	Unit	Unit price	Amount
Road along Section 30/31 (continued)				
4 Piers				
Concrete	610	c.y.	$ 65.00	$ 39,650
Reinforcing steel	85,500	lb.	0.16	13,680
Piling, timber (treated)	3,000	l.f.	4.00	12,000
Excavation, common	1,560	c.y.	3.50	5,460
Backfill	1,320	c.y.	4.50	5,940
Cofferdam and dewater	3	each	10,000.00	30,000
1 Superstructure				
Concrete	335	c.y.	80.00	26,800
Reinforcing steel	77,000	lb.	0.16	12,320
Guard rail	900	l.f.	7.00	6,300
Structural steel A373	263,000	lb.	0.22	57,860
Structural steel A441	150,000	lb.	0.25	37,500
Bridge shoes	12,880	lb.	0.60	7,728
Embankment, fill	327,000	c.y.	0.75	245,250
Excavation, ditch	1,500	c.y.	0.50	750
Gravel surfacing	1,900	c.y.	5.00	9,500
Guard railing	3,400	l.f.	3.50	11,900
Stripping	8,000	c.y.	0.40	3,200
Seeding	4.5	acre	300.00	1,350
Riprap	1,900	c.y.	9.00	17,100
Sub-total				$ 560,753
Contingencies				112,147
Total cost of Remedial Work along Section 30/31				$ 672,900
Road along Section 24/19 (make submersible)				
Miscellaneous work with contingencies	1	job	sum	2,800
Road along Section 18/19				
Raise bridge	1	job	sum	31,000
Raise road including replacement of pavement	1	job	sum	30,000
Total - with contingencies				$ 61,000

DETAILED ESTIMATE OF COST

Item	Quantity	Unit	Unit price	Amount
Road along Section 26/27 (Highway 69) w/contingencies				
Miscellaneous work	1	job	sum	$ 1,500
Telephone and power line Relocations with contingencies	1	job	sum	5,000
Story City sewage disposal plant alteration with contingencies	1	job	sum	17,000
Total Remedial works				$1,970,000
Increment of remedial costs included in original Interstate 35 design				(1) - 161,000
Remedial works chargeable to Reservoir project				1,809,000

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REMEDIAL WORKS FOR CONSTRUCTION WITH INTERSTATE HIGHWAY

Road on Section 6/7	(2) $ 427,000
Road on Section 30/31	(2) 610,000
Sub-total	$1,037,000
Increment chargeable to Highway project (original State Highway estimate)	- 161,000
Increment chargeable to Reservoir project	$ 876,000

(1) The sum of $161,000 is the estimated cost by the State Highway Department for passing the road along Section 6/7 under Interstate 35 and for passing the road along section 30/31 over the Interstate, when the Interstate is built at low level. When the Interstate is built at high level, this cost will not be incurred by the State Highway Department.

(2) This figure represents the cost of providing an over-pass at Interstate 35 with adequate approaches thereto for that interim period prior to completion of the reservoir project at which time the remainder of the road would be elevated to reservoir grade.

SUMMARY

Dam embankment	$ 566,600
Spillway	2,063,400
Outlet works	279,000
Miscellaneous	200,000
Remedial works	1,809,000
Total	$4,918,000
Government costs:	
Engineering and Design	585,000
Supervision and Administration	317,000
REAL ESTATE	
Lands and improvements, less salvage, and plus severance damage, 15 percent contingency, and estimated costs of acquisition and resettlement - 6,500 acres	2,540,000
RECREATIONAL FACILITIES (BOR, present worth)	476,000
INTERSTATE 35	
Increment of cost for constructing Interstate 35 at elevation 973.0 m.s.l in lieu of original design elevation	1,294,000
TOTAL FIRST COST	$10,130,000

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NOTE: It is necessary that side roads between sections 6/7 and between sections 30/31 be partially constructed concurrently with the Interstate highway. The portions properly chargeable to the reservoir project for construction of Interstate highway and incidental cross roads are as follows:

Interstate	$1,294,000
Cross roads	876,000
	$2,170,000

AMES RESERVOIR - SKUNK RIVER, IOWA

APPENDIX C

HYDROLOGY AND HYDRAULICS

U. S. Army Engineer District, Rock Island
Corps of Engineers
Clock Tower Building
Rock Island, Illinois

APPENDIX C

HYDROLOGY AND HYDRAULICS

AMES RESERVOIR - SKUNK RIVER, IOWA

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HYDROLOGY AND HYDRAULICS
AMES RESERVOIR - SKUNK RIVER, IOWA

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TABLES

APPENDIX C

HYDROLOGY AND HYDRAULICS
AMES RESERVOIR - SKUNK RIVER, IOWA

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PLATES

APPENDIX C

HYDROLOGY AND HYDRAULICS

INTERIM REVIEW OF REPORTS
FOR FLOOD CONTROL AND OTHER PURPOSES
ON THE SKUNK RIVER, IOWA - AMES RESERVOIR

I - BASIN DESCRIPTION

1. The Skunk River rises in Hamilton County, Iowa, about 264 river miles above the Mississippi River. The basin is relatively long and narrow, extending from the north-central to the southeastern portions of the State. Its length is approximately 180 miles and its average width about 24 miles. The widest portion of the basin measures about 40 miles. The total fall from the source to the mouth, 9 miles below Burlington, Iowa, is about 680 feet.

2. From the source to a point 5 miles above Ames the valley is narrow and shallow. About 5 miles above Ames the bluffs rise to a height of 75 to 100 feet above the river bed and continue at this height until a short distance above Ames where the river enters a preglacial valley. Immediately below Ames the main stream is joined by Squaw Creek and at this point the valley widens considerably.

3. In the area of Wisconsin drift, the upper one-third of the basin, the topography is gently rolling and the natural drainage in the area is poor although run-off has been accelerated by artificial drainage.

4. In the Kansan and Illinoisan drift areas, the lower two-thirds of the basin, the topography is mature. The inter-stream areas are gently sloping, but near the water courses the terrain becomes steep, in some places rugged.

II - CLIMATOLOGY

5. Precipitation. In the October 1963 Iowa Climatological Data, the U. S. Weather Bureau listed ten precipitation stations in the Skunk River watershed, of which, three are recording stations. The locations of precipitation stations in and adjacent to the Skunk River Basin are shown on plate 1, and data for five stations selected as being representative of the basin, are listed in table C-1. The seasonal distribution of precipitation is favorable to agriculture, the principal industry of the region.

Table C-1

Precipitation Data

Station	Period of record	Precipitation (inches) Average annual(1)	Maximum (2) Depth	Maximum (2) Year	Minimum (2) Depth	Minimum (2) Year
Webster City, Iowa	1870, 1876 1878-1881 1885-1894 1896-1900 1905-1962	28.61	47.15	1881	19.06	1910
Ames, Iowa	1876-1962	31.12	51.90	1881	18.65	1910
Newton, Iowa	1876-1889 1893-1911 1931-1962	32.95	46.70	1905	19.08	1910
Oskaloosa, Iowa	1876-1962	33.79	53.84	1951	15.57	1956
Mount Pleasant, Iowa	1876-1962	34.66	52.13	1902	16.74	1901

(1) U. S. Weather Bureau Climatological Annual Summary for 1962.

(2) U. S. Weather Bureau Climatic Summary of the United States for 1930 and 1931-1962 Annual Summaries.

6. Snowfall. U. S. Weather Bureau records of the average annual snowfall at four stations, Ames, Grinnell, Mount Pleasant, and Oskaloosa, Iowa, which are in or adjacent to the Skunk River watershed, indicate that the average annual snowfall depth over the basin is about 27 inches.

7. Temperatures. Temperature data for five representative stations are given in table C-2. In general, the growing season is of sufficient length to permit maturing of crops.

Table C-2

Temperature Data

Station	Length of record(1)	Temperatures		
		Maximum(2)	Minimum(2)	(1) Average
Webster City, Iowa	57	109°	-34°	47.9°
Ames, Iowa	82	109°	-37°	48.7°
Newton, Iowa	53	110°	-24°	50.2°
Oskaloosa, Iowa	80	112°	-31°	50.8°
Mount Pleasant, Iowa	81	114°	-27°	51.7°

(1) U. S. Weather Bureau Climatological Annual Summary for 1962.

(2) U. S. Weather Bureau Climatic Summary of the United States for 1930 and 1931-1962 Annual Summaries except Newton which is not listed in the 1930 Summary.

III - RUN-OFF AND STREAM FLOW DATA

8. Gaging stations. At present there are seven gaging stations in the Skunk River Basin for which the U. S. Geological Survey publishes stream flow records. Two other stations, Skunk River at Coppock, Iowa, and Squaw Creek at Ames, Iowa, have been discontinued. Pertinent data for these nine stations are given in table C-3.

Table C-3

Gaging Stations - Skunk River and Tributaries

Station and stream	Drainage area sq. mi.	Period of flow record From	To	Maximum observed flow Date	c.f.s.	Gage height	Average flow c.f.s.	Minimum flow c.f.s.	Date	Elevation of gage zero
Ames (8) Skunk River	315	July 1920 Oct. 1932	Sept. 1927 Date	6-10-54 5-20-44	8,630(1) 8,060	13.66 13.90(2)	132	0	Numerous	893.61
Ames (8) Skunk River (Below Squaw Creek)	556	Oct. 1952	Date	3-30-60	9,260	13.20	239	0	Numerous	867.10
Oskaloosa (8) Skunk River	1,635	Oct. 1945	Date	6-15-47 5-23-44	20,000 37,000(4)	21.26(3) 25.8 (3)	792	1.8	From 10-11-56 to 10-13-56	685.50
Coppock (7) Skunk River	2,916	Oct. 1913	Sept. 1944	5-24-44	41,500	22.27	1,350	8	1-27-40 1-28-40	(5)
Augusta (8) Skunk River	4,303	Sept. 1913 Oct. 1914	Nov. 1913 Date	4-3-60	51,000	25.00	2,212	7	From 8-27-34 to 9-1-34	521.24
Ames (7) Squaw Creek	204	May 1919	April 1927 (6)	6-4-18	6,900	14.5(3)	89.8	0	Numerous	(5)
Sigourney (8) North Skunk River	730	Oct. 1945	Date	3-31-60	27,500	25.33	397	0.1	From 10-7-56 to 11-15-56	651.53
Mingo (8) Indian Creek	276	May 1958	Date	5-7-60	5,860	15.07	184	2.2	From 9-13-59 to 9-15-59	810.47
Mt. Pleasant (8) Big Creek	106	Oct. 1955	Date	3-29-60	4,460	15.30	52.9	0	Numerous	630.53

(1) Maximum discharge
(2) Maximum stage
(3) From flood marks
(4) Flow computed by velocity-area method and rating curve extension (limit of rating curve 18,000 c.f.s.)
(5) Not determined
(6) Complete record May 1919 through Sept. 1924. No winter record for remainder of record.
(7) Non-recording stream gaging station
(8) Recording stream gaging station

IV - FLOODS OF RECORD

9. The Skunk River and its tributaries flow through an area which is chiefly agricultural and, except at gaging stations, flood marks are difficult to obtain. Gage records indicate that in general, the major floods occur in May and June; some localized floods occur in August and September as the result of local heavy rainfall. Floods of lesser magnitude sometimes occur during the spring break-up as the result of snow and ice melt in conjunction with moderate rainfall. The spring flood stages are occasionally heightened locally by the formation of ice gorges. Descriptions of the more notable floods, with data obtained from U.S.G.S. Water Supply Papers, are given in the following paragraphs.

10. Flood of June 1903.

The June 1903 flood was caused by heavy rainfall which occurred during the period 25-31 May, following several weeks of intermittent showers. The estimated average precipitation over the Skunk River Basin was about 6 inches for the 7-day period, with amounts up to 9 inches in the central part of the basin. The only high water marks available for this flood are at Coppock and Augusta; exceptional flooding probably occurred also near Oskaloosa and Sigourney. The peak flow at Augusta was about 45,000 c.f.s. with a gage height of about 21 feet on 1 June 1903.

11. Flood of June 1918.

The June 1918 flood resulted from heavy rainfall which occurred during the period 1-6 June. The estimated average precipitation over the basin was about 4 inches for the 6 days with amounts of about 8 inches in the upper part of the basin. Most of the rain fell within a 48-hour period. A flood mark was reported at Squaw Creek station near Ames on 4 June 1903, which is equivalent to a gage height of 14.5 and a flow of 6,900 c.f.s. Peak flows were also recorded at Coppock (28,000 c.f.s. - 19.7 g.h.) and Augusta (27,700 c.f.s.) on 9 and 11 June, respectively.

12. Flood of June 1930.

The June 1930 flood which occurred in the downstream portion of the basin was caused by heavy and intense rains during the period 13-16 June. The average precipitation for the entire basin for the 4-day period is

estimated at 4.5 inches, with portions of the lower basin reporting amounts up to 10.5 inches. For example, the observer at Washington, Iowa, recorded 9.63 inches in 24 hours, and Mount Pleasant recorded 7.59 inches for a 2-day total. Records at Coppock show a flood peak of 40,700 c.f.s. at a 22.13 stage on 15 June and at Augusta a peak flow of 44,500 c.f.s. at a 22.55 stage was observed on 17 June.

13. Flood of August 1943.

The August 1943 flood was caused by localized heavy showers which followed a period of above-normal precipitation. Washington, Iowa, recorded 7.35 inches of rain on 3 August and unofficial records indicated amounts in Henry County of about 12 inches in 24 hours. Gage records show that while an outstanding flood occurred at Coppock (37,400 c.f.s. at 21.57 gage height on 4 August), it had moderated somewhat upon reaching Augusta (29,800 c.f.s. at 20.48 gage height on 6 August).

14. Flood of May 1944.

The May 1944 flood resulted from heavy rains during the period 18-26 May following several months of above-normal precipitation and below-normal temperatures. The estimated average precipitation over the Skunk River Basin was about 5.5 inches for the 9-day period. The maximum rainfall, 15.50 inches, was reported at Nevada, Iowa, of which 8 inches fell in one 12-hour period and 14 inches fell in 36 hours. The rains in the downstream region were heavier during the latter part of the period, thus aggravating the flood condition as the crest moved downstream. This flood established record stages at all stations in the basin, and along the entire length of the river many levees were overtopped with resulting general flooding of the agricultural bottom lands. Rainfall amounts reported were 8.21 inches at Ames on the 19th and 20th, 5.02 inches at Webster City on the 19th and 20th, 6.12 inches at Newton on the 19th , 20th and 21st, and 3.76 inches at Oskaloosa during 19-26 May. The following flood peaks and stages were observed during this flood. Skunk River at Ames, 8,060 c.f.s. at 13.90 stage on 20 May, Coppock, 41,500 c.f.s. at 22.27 stage on 24 May and at Augusta, 44,800 c.f.s. at 23.04 stage on 26 May.

15. Flood of June 1945.

A localized flood occurred on Skunk River near Ames on 2 June 1945. Heavy rainfall above Ames produced a peak flow of 4,010 c.f.s. at a gage height of 9.71.

16. Flood of January 1946.

Warm temperatures and moderate rainfall caused minor flooding on the Skunk River near Oskaloosa and on the North Skunk River near Sigourney on 9 January and 7 January, respectively. The rainfall averaged 1.5 inches and water content of the snow was estimated at 1.5 inches. At Oskaloosa the Skunk River crested at 9,600 c.f.s. and at Sigourney the North Skunk River crested at 14,000 c.f.s. and a 22.57 stage.

17. Flood of June 1946.

The flood of June 1946 was caused by scattered heavy showers over the Skunk River Basin during the period 15-19 June. Ames reported 4.07 inches during the period 17-19 June, Newton had 3.46 inches during the same period, Fairfield experienced 7.93 inches during the period 15-19 June, and Mount Pleasant had 2.85 inches on 18 and 19 June. Skunk River at Coppock crested at 24,200 c.f.s on 20 June and Augusta crested on 22 June with a peak flow of 30,900 c.f.s. at a 20.09 gage height.

18. Flood of June 1947.

The floods of June 1947 resulted from a succession of frequent heavy rains during the period 27 May - 5 July. The average precipitation over the basin for the month of June is estimated at about 11.0 inches, somewhat more than twice the normal amount, and was heaviest over the upper portion of the basin. The month of June 1947 recorded the greatest total monthly rainfall average on record for the State of Iowa. The average for the entire State was 10.39 inches. Peak flows and corresponding stages observed were as follows: Skunk River near Ames 6,550 c.f.s., 11.95 stage on 13 June; Skunk River at Oskaloosa 20,000 c.f.s. on 15 June; North Skunk River near Sigourney 12,000 c.f.s., 21.3 stage on 15 June; Skunk River at Coppock 26,000 c.f.s. on 18 June 1947 and Skunk River at Augusta 29,000 c.f.s., 19.62 stage on 9 June 1947.

19. Flood of June 1950.

Moderate rainfall on the lower half of the Skunk River basin during 13-19 June 1950 produced a moderate flood at Augusta. Oskaloosa had 2.54 inches of rainfall on the 18th and 19th of June, Newton had 2.50 inches on those two days, Mount Pleasant had 5.67 inches on the same two days and Augusta had 2.91 inches on the 18th and 19th and a total of 5.11 inches during the period 13-19 June. The maximum flow at Augusta on 19 June 1950 reached 30,100 c.f.s.

20. Flood of March 1951.

Heavy rainfall above Ames produced a flood crest of 5,320 c.f.s. at a 10.90 stage on the Skunk River near Ames gaging station.

21. Flood of June 1954.

Heavy rainfall above Ames produced local flooding on Skunk River above Ames. Skunk River near Ames crested on June 10th at 8,630 c.f.s. at a 13.66 stage and Skunk River below Squaw Creek near Ames crested at 7,980 c.f.s. at an 11.92 stage on 11 June 1954.

22. Flood of August 1954.

Extremely heavy rainfall over the Squaw Creek basin during the period 22-27 August produced a flood peak of 8,700 c.f.s. at a 12.36 stage on 28 August 1954 at the gage on Skunk River below Squaw Creek near Ames. Rainfall during this 6-day period totalled 10.97 inches at the Ames gage.

23. Flood of June 1957.

Moderate rainfall during the 3-day period 14-16 June 1957 produced minor flooding at the gages on Skunk River near Ames (3,540 c.f.s., 8.28 stage) and on Skunk River below Squaw Creek near Ames (6,360 c.f.s., 11.58 stage) on 16 June 1957. Rainfall for the 3-day period totalled 4.21 inches on the Ames gage.

24. Flood of July 1958.

Rainfall totalling 5.75 inches at the Ames gage during the 3-day period 2-4 July 1958 brought moderate flooding on Skunk River and Squaw Creek above Ames. Skunk River near Ames crested at 3,150 c.f.s. at a 7.85 stage and Skunk River below Squaw Creek near Ames crested at 8,550 c.f.s. at a 12.82 stage on 4 July 1958.

25. Flood of May 1959.

A 3.02 inch rainfall at Ames on 31 May 1959 produced a crest of 5,520 c.f.s. at a 10.57 stage on Skunk River below Squaw Creek near Ames.

26. Flood of March and April 1960.

Temperatures in the 50's coupled with rainfall of about one-half inch produced a rapid melting of the snow cover which held a water equivalent of 1.5 inches near the end of March and the first part of April in 1960. Flood crests were as follows: Skunk River near Ames, 6,210 c.f.s., 10.33 stage on 30 March; Skunk River below Squaw Creek near Ames, 9,260 c.f.s., 13.20 stage on 30 March; Skunk River near Oskaloosa, 14,800 c.f.s., 20.56 stage on 3 April; North Skunk River near Sigourney 27,500 c.f.s., 25.33 stage on 31 March, and Skunk River at Augusta, 51,000 c.f.s., 25.00 stage on 3 April 1960.

27. Flood of July 1961.

Moderately heavy localized rainfall above Ames brought a peak flow of 4,300 c.f.s. at a 9.02 stage on Skunk River near Ames on 14 July 1961. The peak flow on Skunk River below Squaw Creek near Ames reached 6,330 c.f.s. at an 11.87 stage and occurred on 15 July 1961.

28. Flood of May 1963.

A two-day rainfall amount of 3.50 inches on the 11th and 12th of May 1963 brought a flood peak of 4,780 c.f.s. at a 10.20 stage on Skunk River below Squaw Creek near Ames on 12 May.

V - DAMAGING FLOODS

29. The gage at Augusta, Iowa has been maintained continuously since May 1915. Inspection of streamflow records since that time through 30 September 1963 shows that 105 floods with peaks over 10,400 c.f.s. occurred. This is the flow above which damage to crops occurs. Of these 105 flood rises, 90 exceeded 13,300 c.f.s. at which flow property damage occurs. During the period of record, outstanding flows, in excess of 40,000 c.f.s. have occurred three times. On 17 June 1930 the flow reached a peak of 44,500 c.f.s., on 26 May 1944 it reached a peak of 44,800 and 3 April 1960 the flood of record, 51,000 c.f.s. occurred.

30. The gage at Oskaloosa has been maintained since October 1946 with complete records available since October 1948. The records show that the crop zero-damage flow of 3,200 c.f.s. was exceeded 43 times since 1946 and that the property zero-damage flow of 4,650 c.f.s. was exceeded 35 times during the same period. During the period of record, flows in excess of 10,000 c.f.s. occurred three times. On 15 June 1947 a flow of 20,000 c.f.s. was recorded, on 9 March 1949 a flow of 10,800 c.f.s. occurred and on 3 April 1960 a peak flow of 14,800 c.f.s. was observed.

31. The gage near Ames below Squaw Creek was established in October 1952. From that time through September 1963 a total of 16 flood rises greater than the zero crop-damage flow of 2,700 c.f.s. were recorded. In addition, seven of these rises were above the zero property damage flow of 6,100 c.f.s. Four floods of greater than 7,000 c.f.s. were recorded during the period of record.

32. On 11 June 1954 a flow of 7,980 was recorded and 28 August 1954 a peak of 8,700 was observed. On 4 July 1958 a flow of 8,550 c.f.s. was recorded, and the flood of 30 March 1960 crested at 9,260 c.f.s.

VI - SPILLWAY DESIGN FLOOD

33. Ames Reservoir will regulate the run-off from a 314 square mile drainage area upstream of the dam. Rainfall computed as the Probable Maximum Precipitation (P.M.P.) was determined in accordance with the procedures outlined in Hydrometeorological Report No. 33 and distributed throughout the storm duration of 24-hours in accordance with procedures outlined in Civil Works Engineer Bulletin Number 52-8. From the rainfall amounts were deducted infiltration losses determined from Soil Moisture Index (S.M.I.) curves.

34. The run-off increments as derived from Probable Maximum Precipitation were applied to the unit hydrograph ordinates to determine the spillway design flood. A peak inflow of 91,786 c.f.s. would result from this flood determination.

35. Routing the Spillway Design Flood through the Ames Reservoir would produce an outflow rate of 71,000 c.f.s. The maximum reservoir elevation reached was 976.5.

36. The spillway design flood hydrograph and hyetograph are shown on plate C-4 and the reservoir routing is shown on plate C-5.

VII - STANDARD PROJECT FLOOD

37. Nine major storms which have occurred in the general region of the Skunk River watershed were studied in the determination of the standard project flood for Ames Reservoir. The rainfall amounts for several of these storms were adjusted for geographical transposition based on a study made by the Hydrometeorological Section of the Weather Bureau for storm transposition to the adjacent Des Moines River watershed. These adjustments were used in the Skunk River hydrology study. Rainfall amounts in the remaining storms were adjusted by the Rock Island District personnel in accordance with the relationship to probable maximum rainfall shown in Hydrometeorological Section Report No. 23. A comparison of probable maximum rainfall over the area where the storm actually occurred and the probable maximum rainfall over the area upstream from the proposed reservoir provided the adjustment factor for transposition of the observed storm. In addition to the nine major storms, a synthetic storm based on 50 percent of the probable maximum 24-hour rainfall was also studied.

38. Table 4 shows the results of the standard project flood study. The floods produced by these storms were routed through the Ames Reservoir for the 1951 Review Report For Flood Control, Skunk River, Iowa (see paragraphs 5 and 6, main report). The flood control capacity of Ames Reservoir for these routings was 57,900 acre-feet with a 5,600 acre-feet conservation pool and a spillway elevation of 960.0. The proposed plan now envisions a reservoir with flood control pool at elevation 968.0 and with 25,000 acre-feet allocated to water quality and water supply storage, 8,400 acre-feet allocated to sediment storage, and 60,600 acre-feet allocated to flood control storage. The standard project flood study for the 1951 Review Report showed that Storm MR 4-21 produced the highest reservoir stage, exceeding by 2.0 feet the next highest, that produced by Storm UMV 1-22. Three storms produced reservoir stages within a 1.5-foot range. Of these, Storm UMV 1-22 produced the highest reservoir stage, and is considered to be in the category of the greatest storms which can reasonably be expected to occur over the watershed. Therefore, the flood which would result from Storm UMV 1-22 is considered as the standard project flood for the proposed reservoir. The rainfall distribution and timing for this storm is shown on plate C-6. Plate C-7 shows the inflow, outflow and reservoir stage hydrographs from the flood which would be produced by Storm UMV 1-22, together with other pertinent data.

TABLE C-4
COMPARISON OF DATA - STANDARD PROJECT FLOOD FOR AMES RESERVOIR

Storm symbol and date	Transposition adjustment to basin (percent)	Average rainfall (inches)	Average run-off (inches)	Run-off in percent of rainfall	Crest inflow (c.f.s.)	Crest outflow (c.f.s.)	Maximum reservoir elevation (1)
UMV 2-18 12-19 Sept. 1905	92	10.96	7.57	69.1	27,300	9,706	965.8
50% of maximum-possible-24-hour precipitation		9.99	7.86	78.7	37,500	11,800	966.8
UMV 2-5 9-10 June 1905	96	10.23	8.39	82.0	40,900	13,300	967.5
Lathrop, Mo. Center 25 May to 5 July 1947	93	23.36	16.54	70.8	28,200	13,400	967.5
MR 1-10 26-28 Aug. 1903	99	12.29	9.63	78.4	39,600	16,700	968.9
MR 6-15 10-13 June 1944	101	12.40	9.86	79.5	51,400	17,300	969.1
MR 4-24 17-19 Sept. 1926	104	13.03	10.97	84.2	54,100	21,100	970.5
MR 7-2b 11-18 Aug. 1946	89	14.56	11.86	81.5	45,200	23,500	971.4
UMV 1-22 28-31 Aug. 1941	119	15.66	12.53	80.0	50,100	25,400	972.0
MR 4-21 17-21 June 1921	125	17.91	14.58	81.4	66,900	31,600	974.0

(1) Based on a fixed spillway at elevation 960. See paragraph 38 for explanation.

VIII - UNIT HYDROGRAPHS

39. The unit hydrograph used for computing the spillway design flood was developed from observed hydrographs at the Skunk River gage above Ames which is only about one mile downstream from the dam site. The unit hydrograph developed had a crest of 6,148 c.f.s. and a precipitation-excess duration of 6 hours. The time from beginning of run-off to hydrograph peak was 8 hours for the unit hydrograph developed for the spillway design flood.

40. Another unit hydrograph used for lesser floods was developed which had a crest of 5,425 c.f.s., a 6-hour duration, and a peaking time of 18 hours. These unit hydrographs are shown on plate C-2.

IX - HYDRAULIC AND HYDROLOGIC DATA

41. Storage capacity. Plate C-1 shows the area-capacity curve. The total storage capacity of the reservoir at full pool elevation 968.0 is 94,000 acre-feet. Storage in the reservoir is allocated as follows:

Purpose	Storage allocation acre-feet	Elevation
100-year sediment reserve	8,400	932.0
Water quality and water supply	25,000	949.0
Flood control	60,600	968.0

The flood control capacity is equivalent to 3.62 inches of run-off from the 314 square mile drainage area controlled by the reservoir. At this time it has not been firmly established whether the allocation of 25,000 acre-feet to water quality control and water supply represents a gross or a net need. In this connection, therefore, an analysis was made to determine the evaporation, transpiration and ice losses that would affect the available storage for those purposes. This analysis is given in paragraphs 48 - 53, below.

42. The presence of a low area at elevation 991.0 on the right bluff imposes a restriction on storage available for the Ames Reservoir. No particular problem is posed under the present plan which utilizes a gated spillway with crest at elevation 953.0, since the maximum reservoir elevation reached during spillway design flood routing is 976.5. If an ungated spillway with crest at elevation 968.0 were to be used, however, there would have to be some corrective work done to prevent overflow from the reservoir under spillway design flood conditions.

43. Spillway. A saddle spillway located in the left bluff would be provided. The gated spillway would consist of 230 foot wide approach channel about 1,425 feet long, a 200-foot long by 230-foot wide broad-crested weir control section, and a 1,30-foot long exit channel. The spillway plus outlet rating curve is shown on plate C-3.

44. Outlet structure. The Review Report (1951) provided an ungated 7-foot diameter circular conduit for flood control regulation. The present study contemplates that the outlet conduit will be gated in order to provide maximum flood control reductions from the single reservoir system.

45. Reservoir operation. During flood periods, the Ames Reservoir conduit flow will be operated to control flows not to exceed 1,000 c.f.s., insofar as possible, at the Ames gage on Skunk River below Squaw Creek. Conduit flows will be zero during high flow periods on

Squaw Creek to provide maximum flood reductions downstream. After a flood, the gates will also be operated to evacuate the flood storage so that the flow on the gage below Squaw Creek does not exceed 1,000 c.f.s. After evacuating flood storage, the conservation pool would be operated at elevation 949.0 except as required to augment low flows for water quality control.

46. During periods of low flow augmentation for water quality control and water supply, the reservoir will be operated so as to maintain a flow of 78 c.f.s. past Ames gaging station. This operation will be accomplished by drafting on the storage allocated to water quality control and water supply. Seventy-eight c.f.s. is approximately 60 percent of the mean annual daily discharge.

47. Degree of protection. The flood storage capacity of the Ames Reservoir, 3.62 inches, is sufficient to modify the standard project flood, routed into an initially empty flood pool, from a peak inflow of 50,100 c.f.s. to a peak outflow of 37,500 c.f.s. Allowing for outflow during the flood, the reservoir could control a flood with approximately 34 percent of the volume of the standard project flood (12.53 inches) and limit the outflows to non-damaging levels below the dam.

48. Evaporation, transpiration and ice losses from the water quality control and water supply storage. Evaporation, transpiration and ice losses were based on studies made for the Supplement No. 1 to Design Memorandum No. 3 - Conservation Storage, Red Rock Reservoir, Des Moines River, Iowa. The evaporation data in the Red Rock Reservoir studycalculated from U. S. Weather Bureau "Class A" land pan records at Ames, Iowa. Because of the proximity of the Red Rock reservoir to the Ames Reservoir site, the loss values in the study for that reservoir are considered to be applicable to the Ames Reservoir study. The Ames Weather Bureau records included 26 years of evaporation records during the months of April through October. The mean monthly land pan evaporation values were reduced to equivalent lake evaporation using a coefficient of 0.73 as obtained from U.S.W.B. Technical Paper No. 37, "Evaporation Maps for the United States".

49. The equivalent lake evaporation values were increased by 50 percent to represent somewhat more severe evaporation conditions than would mean values. November-February values were taken from "Evaporation from Lakes and Reservoirs", by Adolph F. Meyer, and these values were not modified. Transpiration losses were estimated to be one-third of the corresponding evaporation values, with no transpiration loss assigned after 31 October. The transpiration loss estimates were based on the "Water Loss Investigations - Lake Hefner Studies", U.S.G.S. Professional Paper No. 269. Mean monthly precipitation records were tabulated for the Des Moines, Iowa, 83-year record. The

selected precipitation values were 10 percent of the mean monthly values as typical of severe drought conditions in the Great Plains region. Ice losses totaling 3.0 feet were assigned to the months of November and December. This water, although remaining physically in storage in the form of ice, is unavailable for flow augmentation until the spring thaw and should be considered a loss during the winter drawdown. Table C-5 indicates, by months, the total losses from evaporation, transpiration and ice with an adjustment for precipitation falling directly on the reservoir.

50. The Red Rock study showed an 8-month drought period to be the most critical with the drought starting in July and ending with the spring breakup which usually occurs during the month of March in this region. The net total loss for the critical 8-month period, July through February is 6.33 feet. Assuming that the water quality control and water supply pool contains 25,000 acre-feet at elevation 949.0 at the beginning of the critical period, the losses will reduce the usable conservation storage to 13,600 acre-feet by the end of the 8-month period. In order to assure that 25,000 acre-feet of net storage will be available for flow augmentation after deducting losses, the pool must contain 41,600 acre-feet at the beginning of this critical 8-month period. This volume, together with 8,400 acre-feet of sediment storage, corresponds to approximately elevation 955.3.

51. Sedimentation. Suspended sediment records are not available since no sampling stations have been maintained in the Skunk River basin. Thus, there are no directly observed data on which to base sediment production rates for the Skunk River watershed. However, sampling stations maintained on the Des Moines River and Iowa River provide a good indication of the sediment load transported by the Skunk River when a comparison of the soil types and topography are made. That portion of the Skunk basin lying upstream from the Polk-Jasper County line, together with the upper parts of the Des Moines and Iowa River basins were covered by the most recent glacier to invade Iowa. These three basins therefore have soils that were produced under the same condition and, except for a portion of the Iowa River watershed immediately upstream from Marshalltown, have generally the same type of flat to gently rolling topography. An examination of the topography of the Des Moines River watershed below Des Moines and the Skunk River watershed below Highway No. 6 in Jasper County, indicates a marked difference from the upper reaches of both streams. The topography becomes increasingly rugged throughout the Des Moines and Skunk basins, indicating much steeper drainage patterns which consequently increase the sediment production rates considerably. Suspended sediment sampling stations have been continuously maintained since 1940 at two locations on the Des Moines River near Boone and near Tracy, Iowa. Sediment sampling has also been continuously maintained since 1940 on the Raccoon River near Van Meter, Iowa, and on the Iowa River near Marshalltown, Iowa, since 1944. For each of the four above-mentioned

sediment sampling stations, mean monthly values of suspended sediment load as determined from mean daily suspended sediment loads for the entire period of record were plotted against the corresponding mean monthly river discharge for the respective gaging stations. From this plot, a curve of mean monthly flow versus mean monthly suspended load was drawn. Based upon this curve, the mean monthly suspended sediment load for each month of the year for the entire period of flow record was computed.

52. Determination of total sediment load above Ames Reservoir. From the sediment records obtained in the manner described in the preceding paragraph, it was determined that the long-term average annual suspended sediment load for the Marshalltown station was 630,000 tons per year, or approximately 403 tons per square mile per year. The long-term average annual suspended sediment load for the Boone station was computed as 980,000 tons per year, or approximately 178 tons per square mile per year. The unadjusted annual syspended load for the Skunk River above Ames Reservoir was determined by averaging the Marshalltown and Boone sediment loads, which gives a value of 290 tons per square mile. Numerous observations show that smaller drainage areas have greater sediment production rates than larger basins. This adjustment for the size of drainage area relationship increases the suspended sediment load for Ames Reservoir to approximately 337 tons per square mile per year. Further adjustment of the suspended load to account for the unmeasured bed load is made by assuming that 10 percent of the total load is bed load. This assumption indicates that the total annual sediment load entering Ames Reservoir is about 375 tons per square mile per year.

53. Deposition of sediment in proposed Ames Reservoir. The trap efficiency of Ames Reservoir was computed in accordance with methods developed by the ASCE Task Force on Rates of Reservoir Sedimentation, as published in the February 1960 issue of the Journal of the Hydraulics Division, ASCE, entitled "Trap Efficiency of Reservoirs, Debris Basins, and Debris Dams". Based on the ratio of the capacity at full pool (elevation 968.0) of 94,000 acre-feet versus the reservoir inflow in acre-feet per year (C/I), the trap efficiency of Ames Reservoir would be about 97 percent. The total annual sediment load entering Ames Reservoir from the 314 square mile drainage area is approximately 117,700 tons. Assuming 97 percent entrapment gives a deposition rate of 114,000 tons per year. The volume which this will occupy depends upon its weight in place. The weight in place will depend upon the fluctuation of the reservoir level which will permit drying and consolidation of the deposits. Since Ames Reservoir will have a water quality control and water supply pool, it is assumed that the average specific weight of the sediment in place would be 62 pounds per cubic foot. Based on these figures, the average annual sediment volume trapped in Ames Reservoir would be about 84 acre-feet. The 100-year volume of sediment entrapment would be 8,400 acre-feet, which represents a loss of about 9 percent of reservoir capacity at spillway elevation.

X - FREQUENCY CURVES

54. Discharge-frequency curves were developed for Skunk River at Augusta, Skunk River near Oskaloosa, Skunk River below Indian Creek, and Skunk River below Squaw Creek near Ames.

55. The natural curves for Skunk River at Augusta were developed from 61-years of record for the all-year curve and 47 years of record for the crop season curve using the Beard Method for frequency analysis. The modified curves were developed from reservoir flow modifications routed to Augusta. In Augusta there was practically no difference between natural and modified frequency curves.

56. The natural frequency curve for Oskaloosa was developed from a correlation between the 20-year record at Oskaloosa and the 61-year record at Augusta. The resultant frequency curve would have the equivalent of a 35-year record. The crop season curve was computed from a 16-year record. The modified frequency curves were also computed from reservoir flow modifications routed to Oskaloosa.

57. The frequency curves for the reach below Indian Creek were developed from a plot of flow in c.f.s. per square mile versus drainage area in square miles which was done on logarithmic graph paper using the other stations on the Skunk River as points on the curves.

58. The frequency curves for Skunk River below Squaw Creek near Ames, Iowa were developed by extending the 11-year record at that station by correlation with the 38-year record for the gage on Skunk River near Ames. The resulting frequency curve is equivalent to a frequency curve developed from a 28-year record. The frequency curves for all reaches are shown on plates C-8 through C-11. These frequency curves are based on flood storage of 57,900 acre-feet. The flood storage available in the presently proposed flood pool which was selected subsequent to developing these curves, is 60,600 acre-feet. It was decided not to refine the curves to reflect the slight increase in flood storage available.

XI - DISCHARGE RATING CURVES

59. Discharge rating curves were available for all reaches except below Indian Creek. These available rating curves were extrapolated to the 100-year frequency discharge on the basis of valley cross-sections and other information available.

60. The rating curve for the Skunk River below Indian Creek was developed entirely from stream and valley cross-sections and observed high water marks. The discharge rating curves for all reaches are shown on plates C-12 through C-15.

TABLE C-5

Pertinent Data

Ames Reservoir, Skunk River, Iowa

Dam

Location of dam, mile 220.6
Type - Earth embankment across valley and saddle spillway in left bluff
Dimensions (approximate)
Maximum height, above stream bed 93 feet
Net spillway width 200 feet - with five 40'x16' crest gates
Elevations
Top of dam 985
Spillway weir crest 953
Valley floor (approximate) 910
Water quality and water supply pool 949

Reservoir

Drainage area above dam 314 square miles
Capacity at flood pool level 94,000 acre-feet
Capacity allocated to flood control 60,600 acre-feet
Capacity allocated to water quality control and water supply 25,000 acre-feet
Capacity for sediment storage 8,400 acre-feet
Flood control capacity, inches of run-off 3.62
Length 7.0 valley miles
Area below flood pool level 4,350 acres
Area below water quality control and water supply pool 2,100 acres

Hydrologic data

Spillway design flood

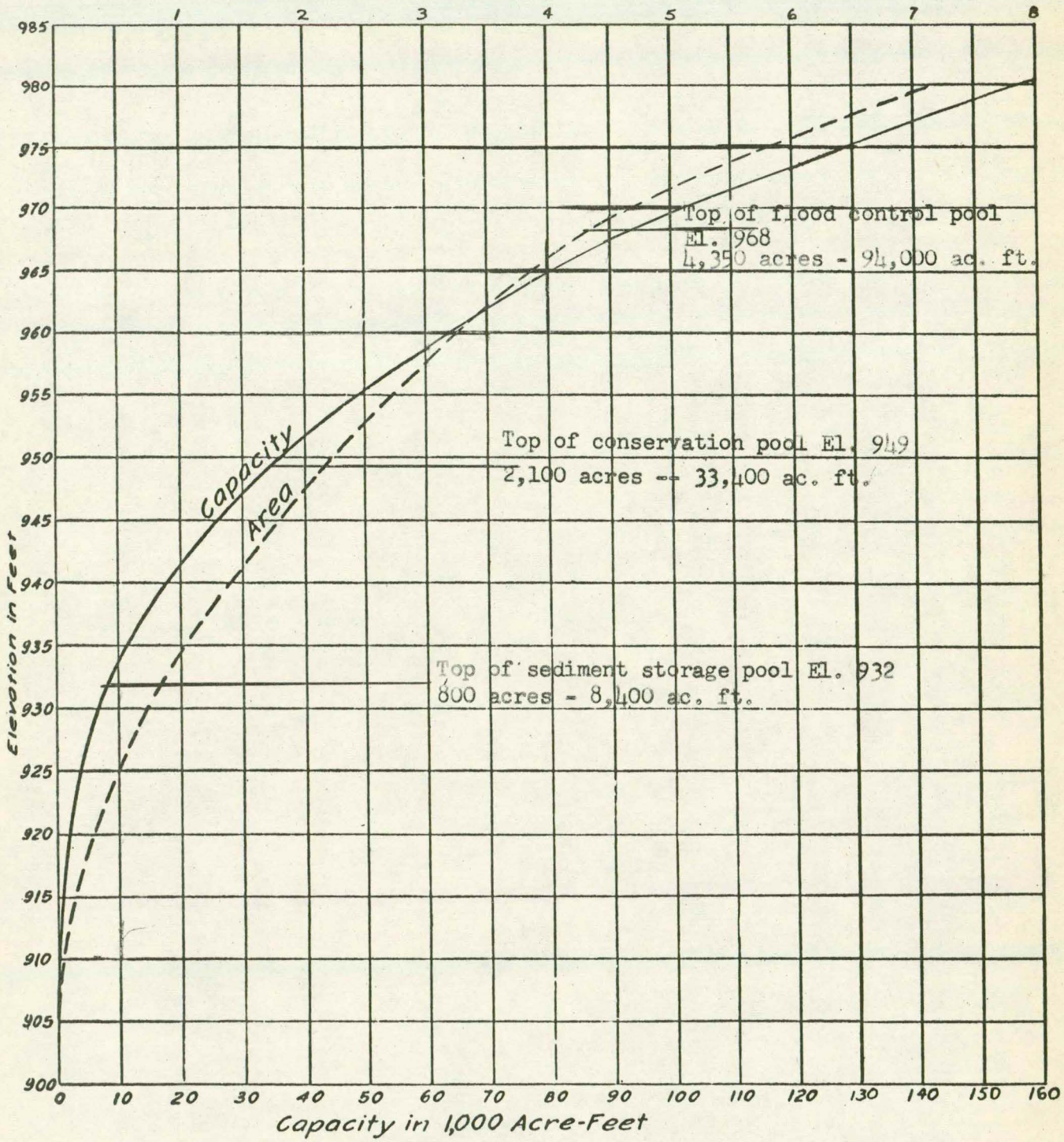
Total rainfall 20.02 inches
Total run-off 17.74 inches
Crest inflow, 91,800 c.f.s.
Crest outflow, 71,000 c.f.s.
Maximum reservoir elevation 976.5

TABLE C-6

EVAPORATION, TRANSPIRATION AND ICE LOSSES IN AMES RESERVOIR

(1) Month	(2) Mean Monthly evap.(inches) Ames	(3) Selected Monthly evap.(inches) Col.(2)x0.73x1.50	(4) Estimated transpiration Col.(3) x 1/3 (inches)	(5) Total evaporation-transpiration losses(inches)	(6) Mean monthly precipitation* (inches)	(7) Selected monthly precipitation (inches)	(8) Estimated ice storage (inches)	(9) Total losses Col.(5)-Col.(7)+Col.(8) (inches)	(10) (feet)
JUL	9.25	10.18	3.39	13.57	2.96	0.30	0	13.27	1.11
AUG	7.55	8.30	2.76	11.06	3.83	0.38	0	10.68	0.89
SEP	5.59	6.15	2.05	8.20	3.66	0.37	0	7.83	0.63
OCT	3.62	3.98	1.33	5.31	2.25	0.22	0	5.09	0.42
NOV	2.00	2.00	0	2.00	1.66	0.17	18.0	19.83	1.65
DEC	0.70	0.70	0	0.70	1.15	0.12	18.0	18.58	1.55
JAN	0.50	0.50	0	0.50	1.22	0.12	0	0.38	0.03
FEB	0.65	0.65	0	0.65	1.07	0.11	0	0.54	0.05
		32.46	9.53	41.99		1.79	36.0	76.20	6.33

*At Des Moines, Iowa



AREA CAPACITY CURVES

PLATE C-1

SKUNK RIVER, IOWA
AMES RESERVOIR
6-HR. UNIT HYDROGRAPHS

ROCK ISLAND DISTRICT CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

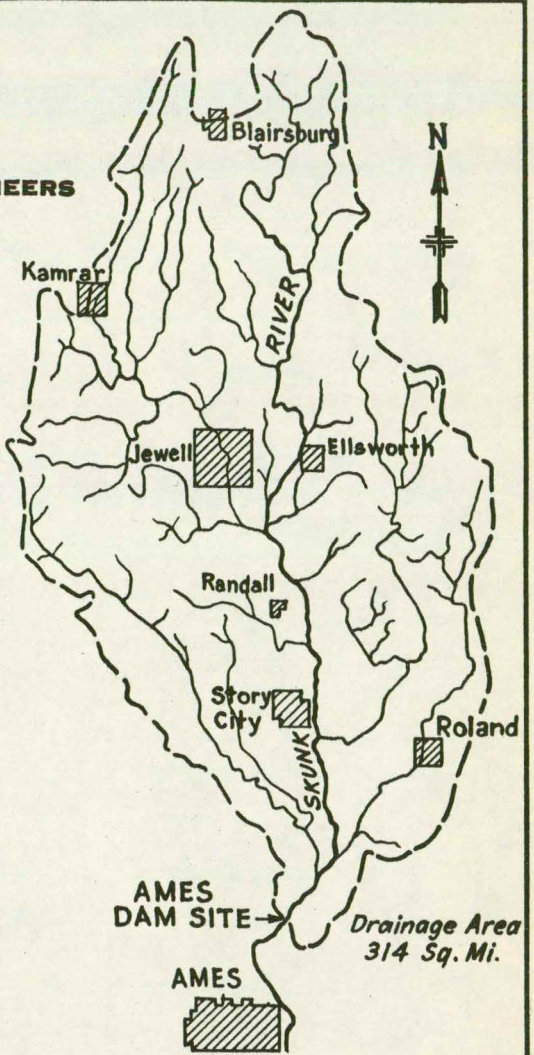


PLATE C-2

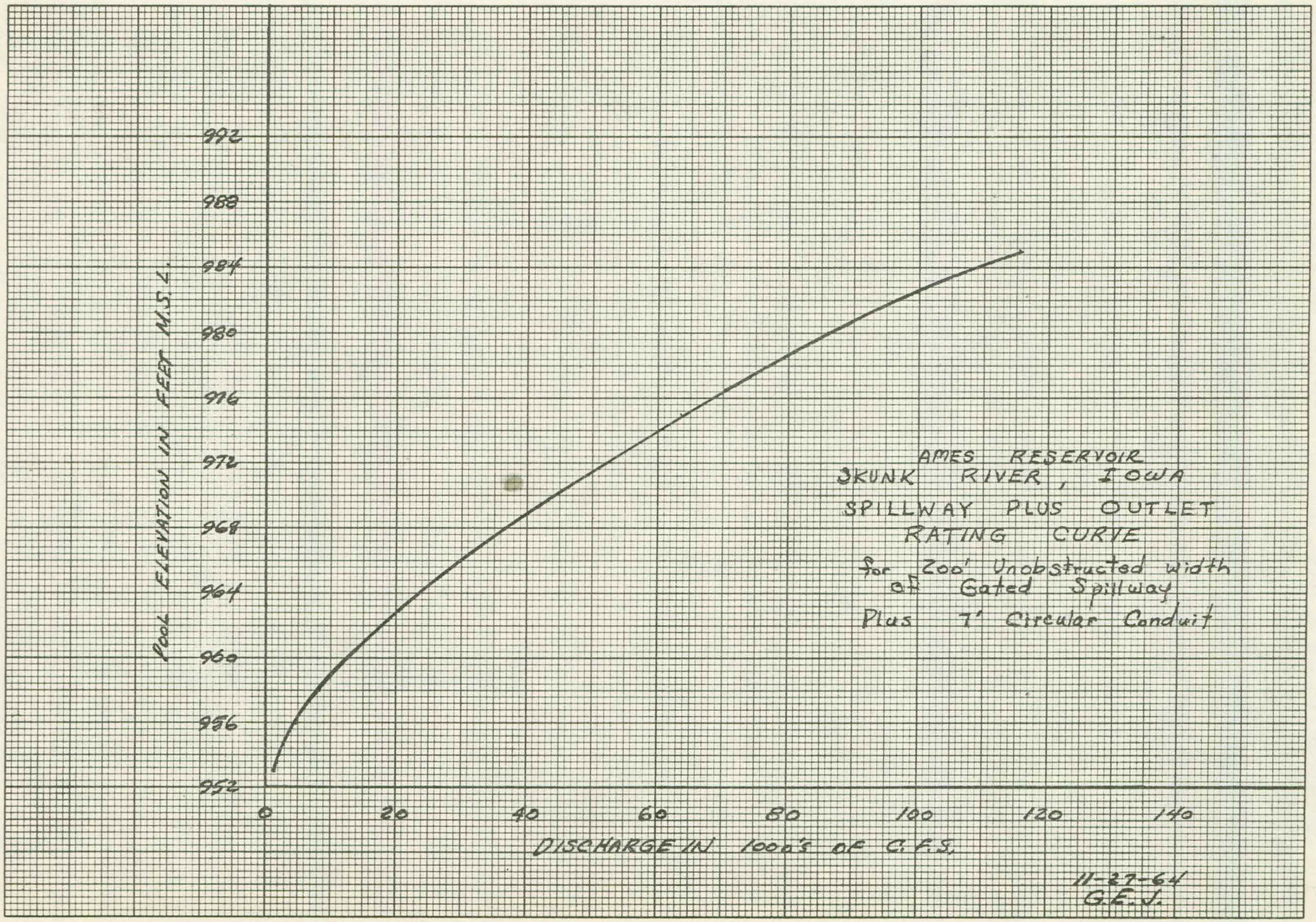

992
988
984
980
976
972
968
964
960
956
952
POOL ELEVATION IN FEET M.S.L.
0
20
40
60
80
100
120
140
DISCHARGE IN 1000's OF C.F.S.
AMES RESERVOIR
SKUNK RIVER, IOWA
SPILLWAY PLUS OUTLET
RATING CURVE
for 200' Unobstructed width of Gated Spillway
Plus 7' Circular Conduit
11-27-64
G.E.J.

PLATE C-3

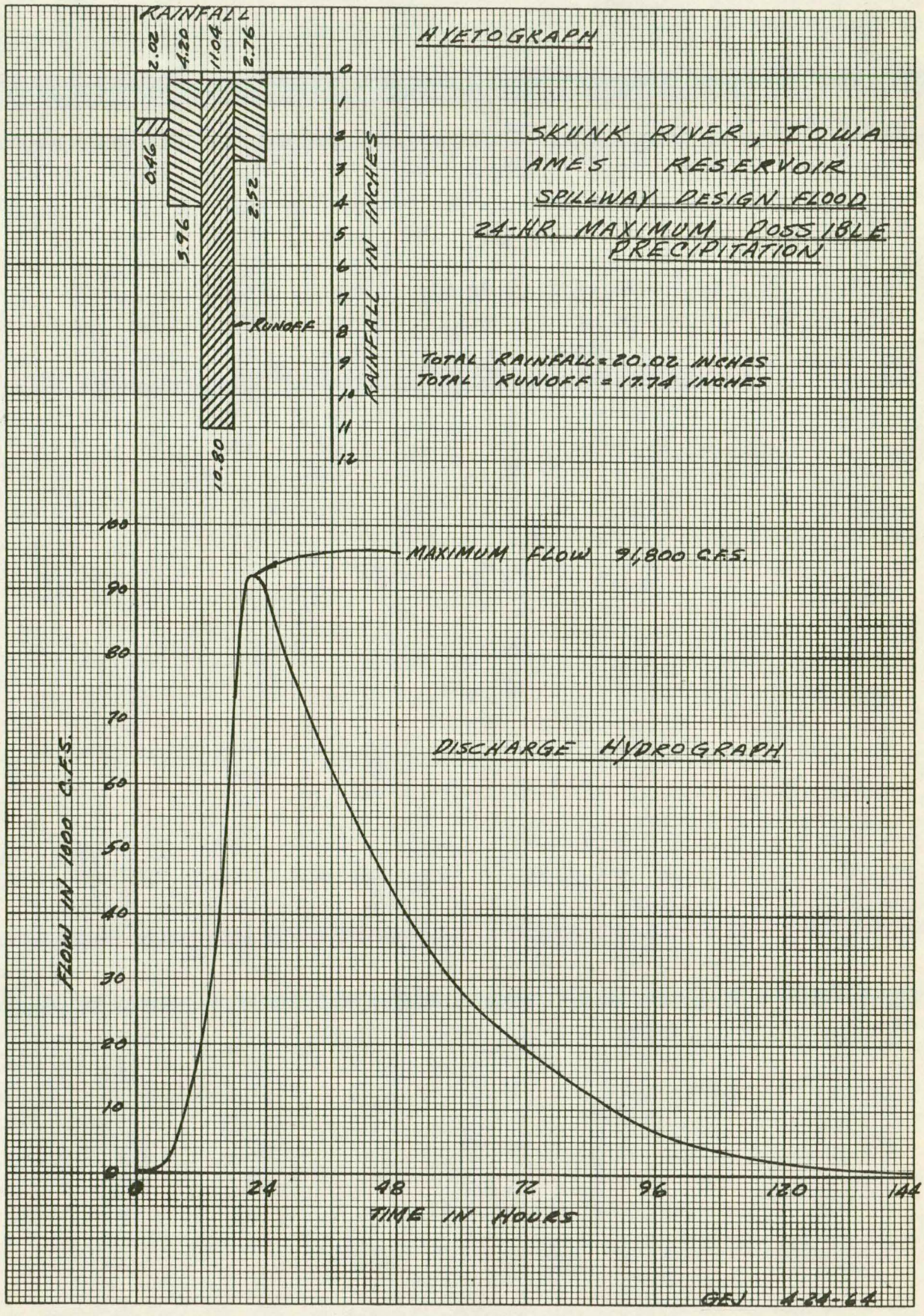

HYETOGRAPH
RAINFALL
2.02
4.20
11.04
2.76
0.46
3.96
10.80
2.52
RUNOFF
RAINFALL IN INCHES
0
1
2
3
4
5
6
7
8
9
10
11
12
SKUNK RIVER, IOWA
AMES RESERVOIR
SPILLWAY DESIGN FLOOD
24-HR. MAXIMUM POSSIBLE PRECIPITATION
TOTAL RAINFALL = 20.02 INCHES
TOTAL RUNOFF = 17.74 INCHES
MAXIMUM FLOW 91,800 C.F.S.
DISCHARGE HYDROGRAPH
FLOW IN 1000 C.F.S.
100
90
80
70
60
50
40
30
20
10
0
0
24
48
72
96
120
144
TIME IN HOURS
GEJ 4-24-64

Plate C-4

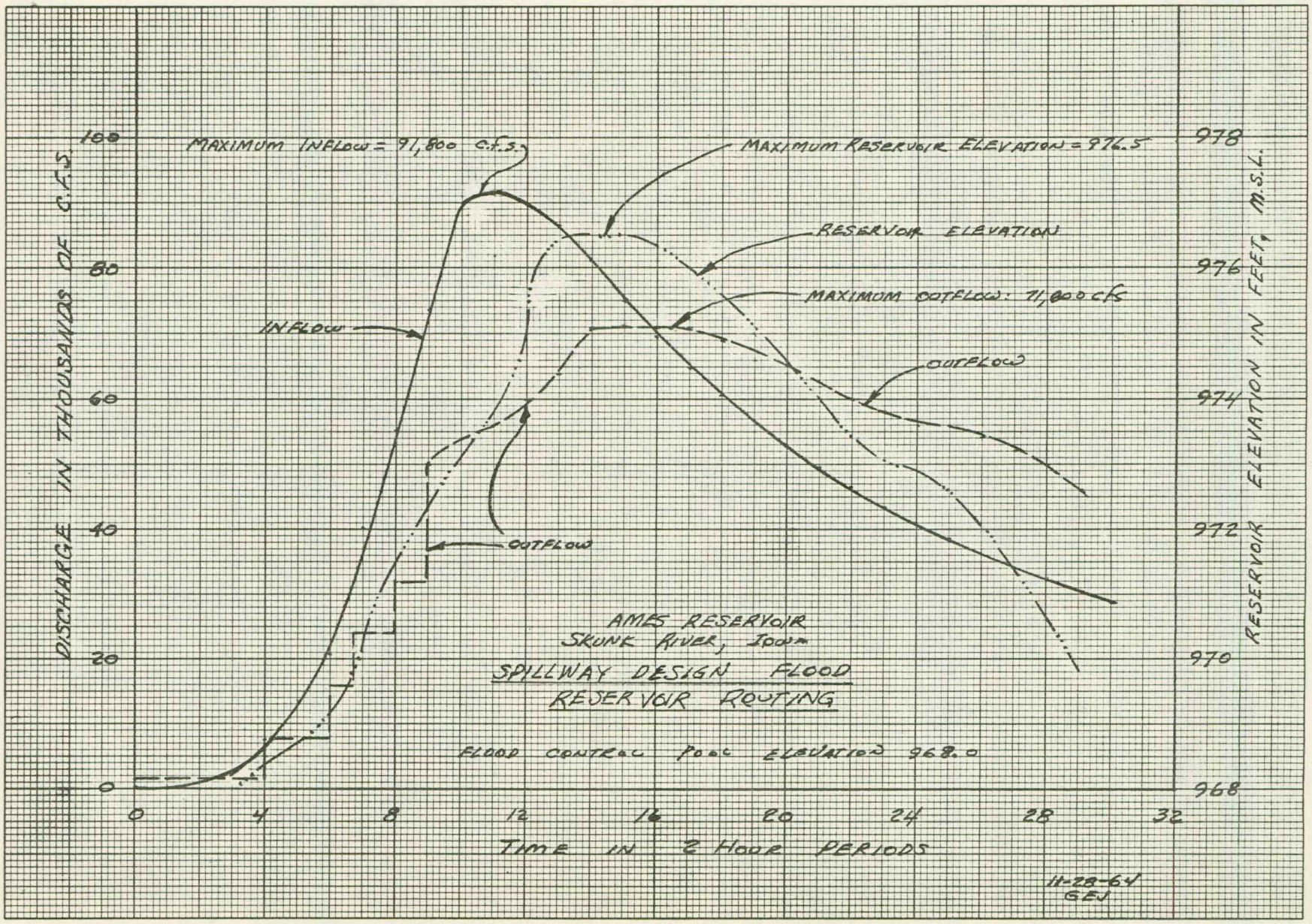
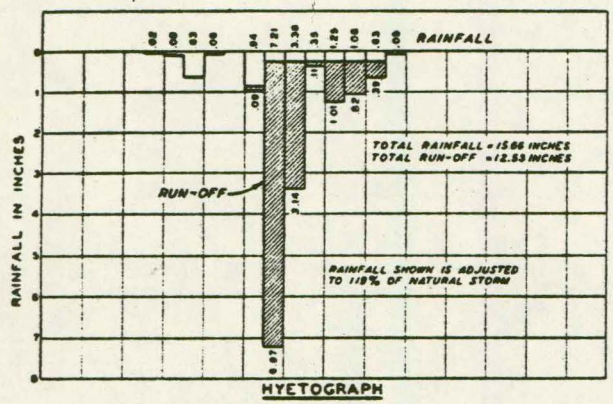
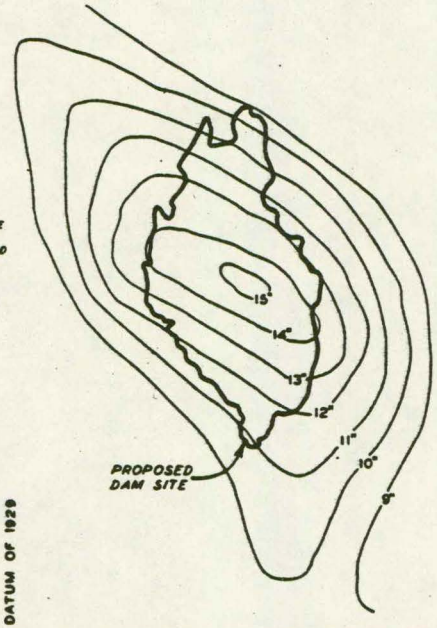

MAXIMUM INFLOW = 91,800 c.f.s.
MAXIMUM RESERVOIR ELEVATION = 976.5
RESERVOIR ELEVATION
MAXIMUM OUTFLOW: 71,800 cfs
INFLOW
OUTFLOW
OUTFLOW
DISCHARGE IN THOUSANDS OF C.F.S.
RESERVOIR ELEVATION IN FEET, M.S.L.
100
80
60
40
20
0
978
976
974
972
970
968
0
4
8
12
16
20
24
28
32
TIME IN 2 HOUR PERIODS
AMES RESERVOIR
SKUNK RIVER, IOWA
SPILLWAY DESIGN FLOOD
RESERVOIR ROUTING
FLOOD CONTROL POOL ELEVATION 968.0
11-28-64
GEJ

PLATE C-5



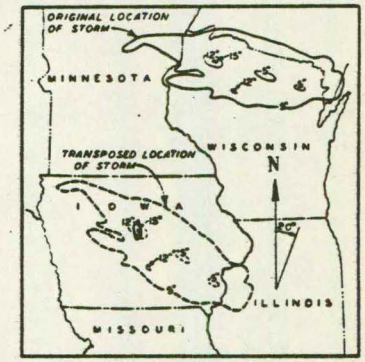
HYETOGRAPH

NOTE:
RAINFALL MAP SHOWS SAME AMOUNT AS ACTUAL OCCURRENCE IN NATURAL STORM
THE STANDARD PROJECT FLOOD IS COMPUTED FROM THIS STORM ADJUSTED TO 118% FOR CHANGE IN LOCATION

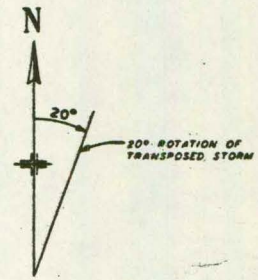


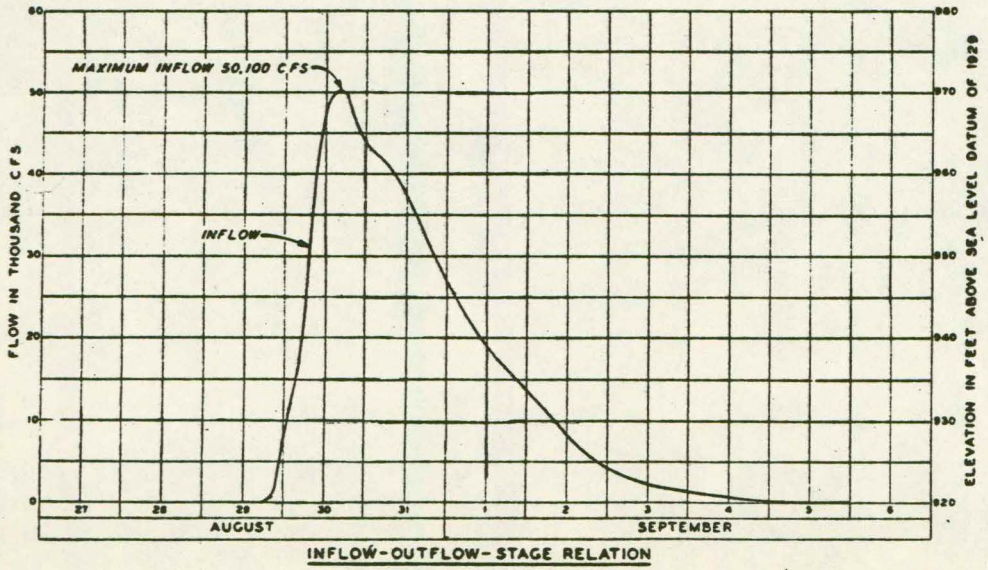
ISOHYETAL MAP OF TRANSPOSED STORM

10 0 10 20
SCALE IN MILES



STORM TRANSPOSITION MAP





INFLOW-OUTFLOW-STAGE RELATION

SKUNK RIVER, IOWA
AMES RESERVOIR
STANDARD PROJECT FLOOD
STORM OF 28-31 AUGUST 1941
UMV 1-22

ROCK ISLAND DISTRICT CORPS OF ENGINEERS

PLATE C-6

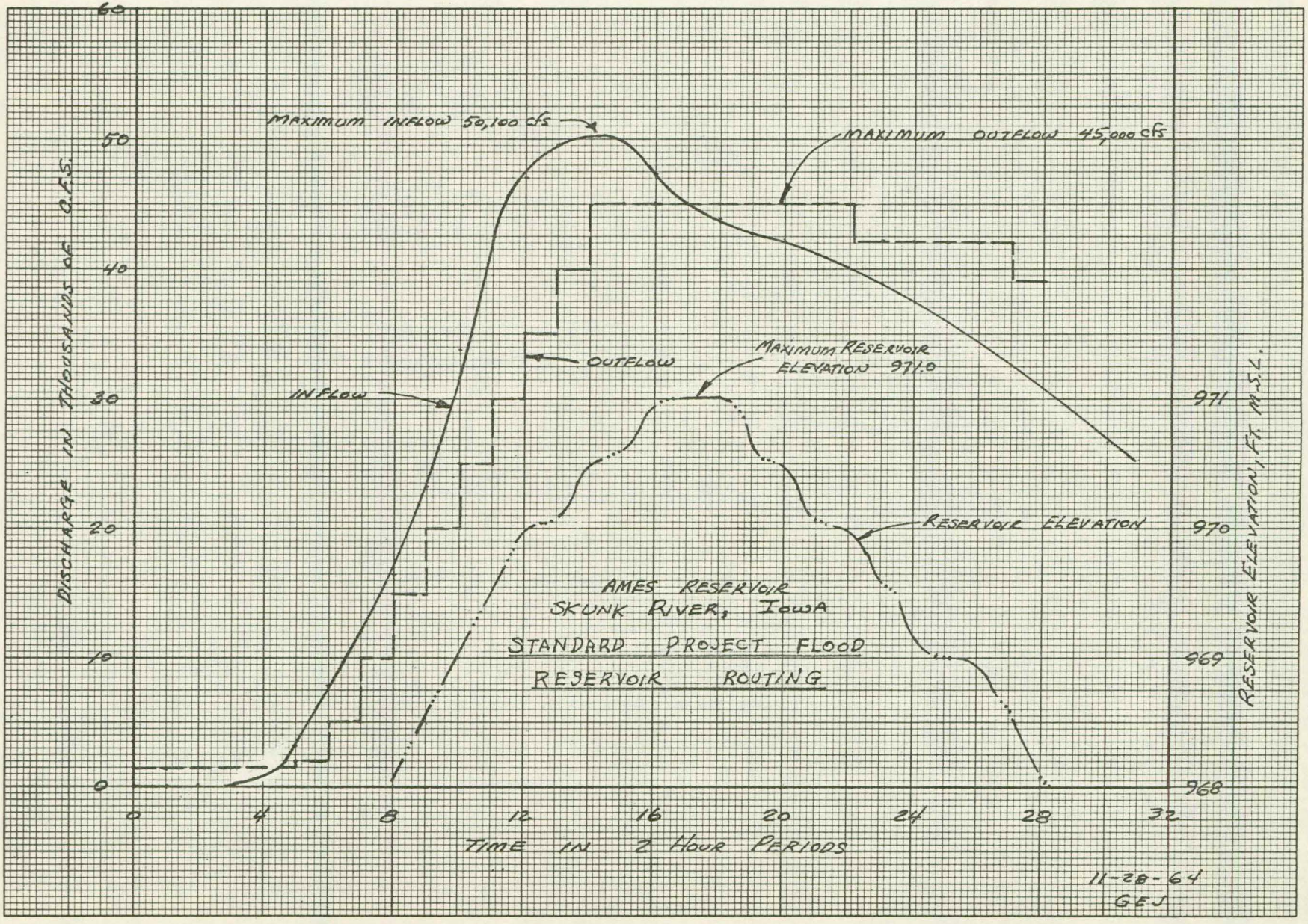

MAXIMUM INFLOW 50,100 cfs
MAXIMUM OUTFLOW 45,000 cfs
OUTFLOW
INFLOW
MAXIMUM RESERVOIR ELEVATION 971.0
RESERVOIR ELEVATION
AMES RESERVOIR
SKUNK RIVER, IOWA
STANDARD PROJECT FLOOD
RESERVOIR ROUTING
DISCHARGE IN THOUSANDS OF C.F.S.
RESERVOIR ELEVATION, FT. M.S.L.
TIME IN 2 HOUR PERIODS
60
50
40
30
20
10
0
971
970
969
968
0
4
8
12
16
20
24
28
32
11-28-64
GEJ

PLATE C-7

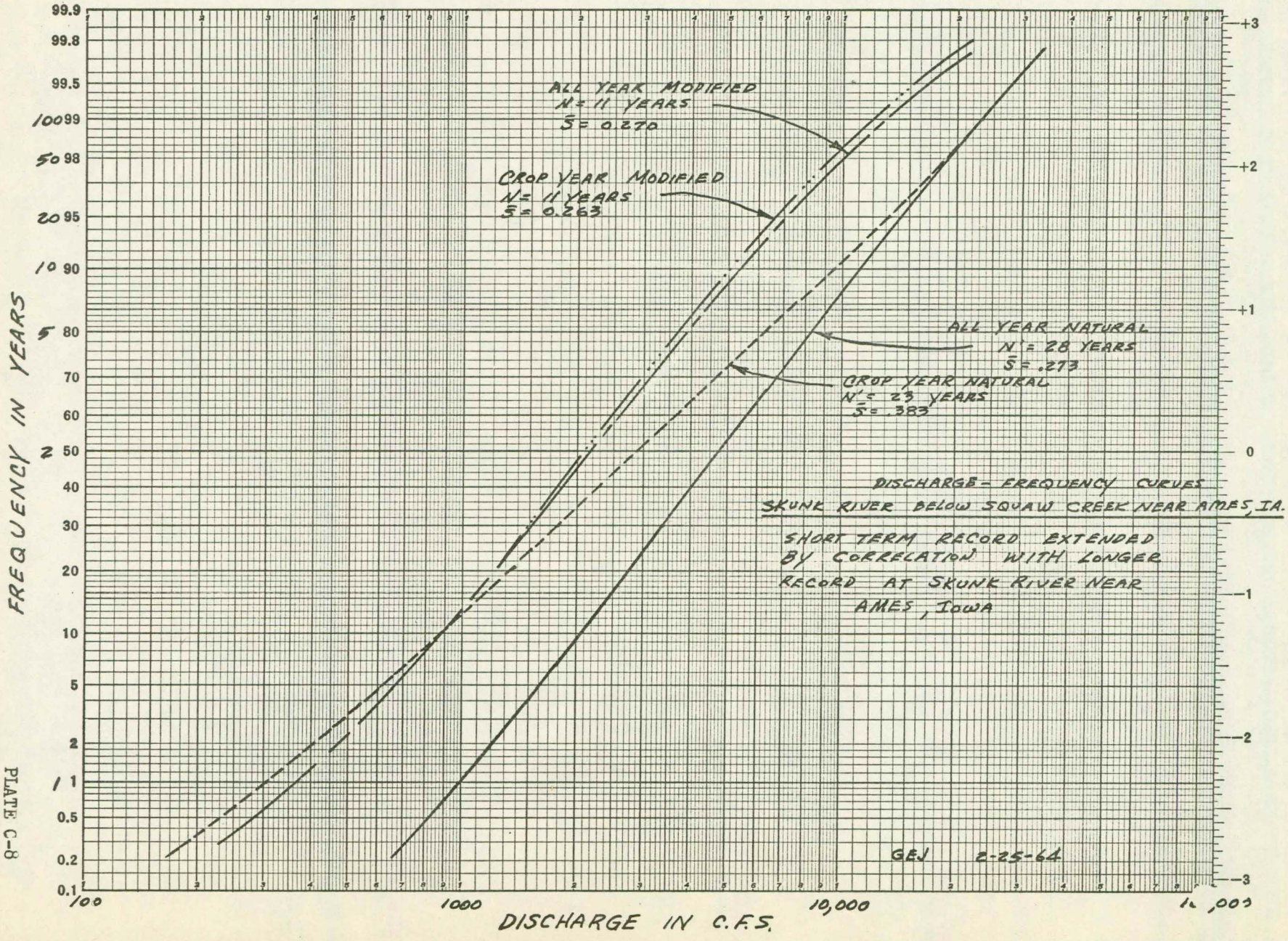

ALL YEAR MODIFIED
N = 11 YEARS
S̄ = 0.270
CROP YEAR MODIFIED
N = 11 YEARS
S̄ = 0.263
ALL YEAR NATURAL
N = 28 YEARS
S̄ = .273
CROP YEAR NATURAL
N = 23 YEARS
S̄ = .383
DISCHARGE - FREQUENCY CURVES
SKUNK RIVER BELOW SQUAW CREEK NEAR AMES, IA.
SHORT TERM RECORD EXTENDED BY CORRELATION WITH LONGER RECORD AT SKUNK RIVER NEAR AMES, IOWA
GEJ 2-25-64
FREQUENCY IN YEARS
DISCHARGE IN C.F.S.
99.9
99.8
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
100
1000
10,000
+3
+2
+1
0
-1
-2
-3

PLATE C-8

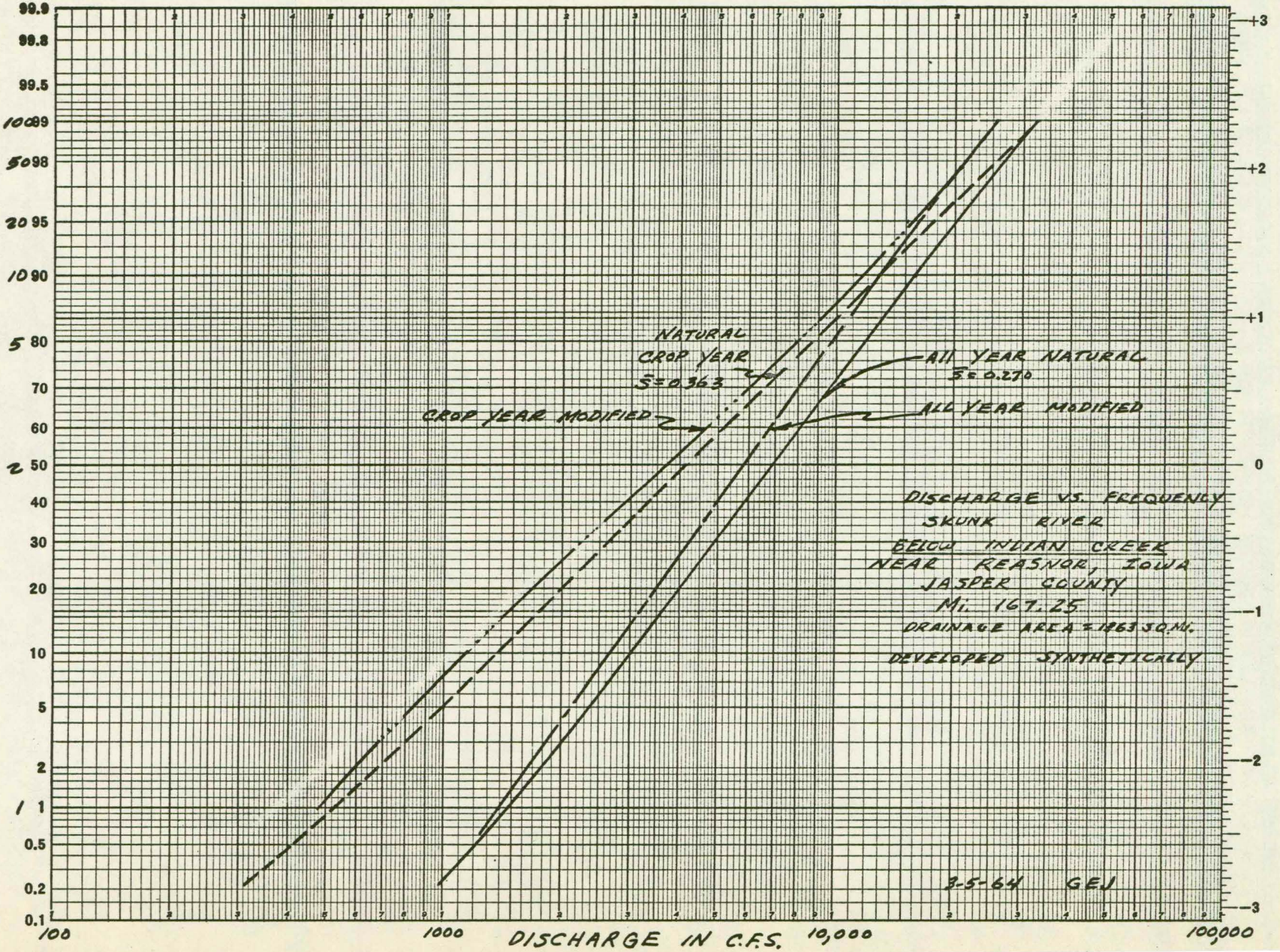

FREQUENCY IN YEARS
99.9
99.8
99.5
100 99
50 98
20 95
10 90
5 80
70
60
2 50
40
30
20
10
5
2
1 1
0.5
0.2
0.1
+3
+2
+1
0
−1
−2
−3
NATURAL
CROP YEAR
S=0.363
CROP YEAR MODIFIED
ALL YEAR NATURAL
S=0.270
ALL YEAR MODIFIED
DISCHARGE VS. FREQUENCY
SKUNK RIVER
BELOW INDIAN CREEK
NEAR REASNOR, IOWA
JASPER COUNTY
Mi. 167.25
DRAINAGE AREA = 1863 SQ.MI.
DEVELOPED SYNTHETICALLY
3-5-64 GEJ
100
1000
DISCHARGE IN C.F.S.
10,000
100,000

PLATE C-9

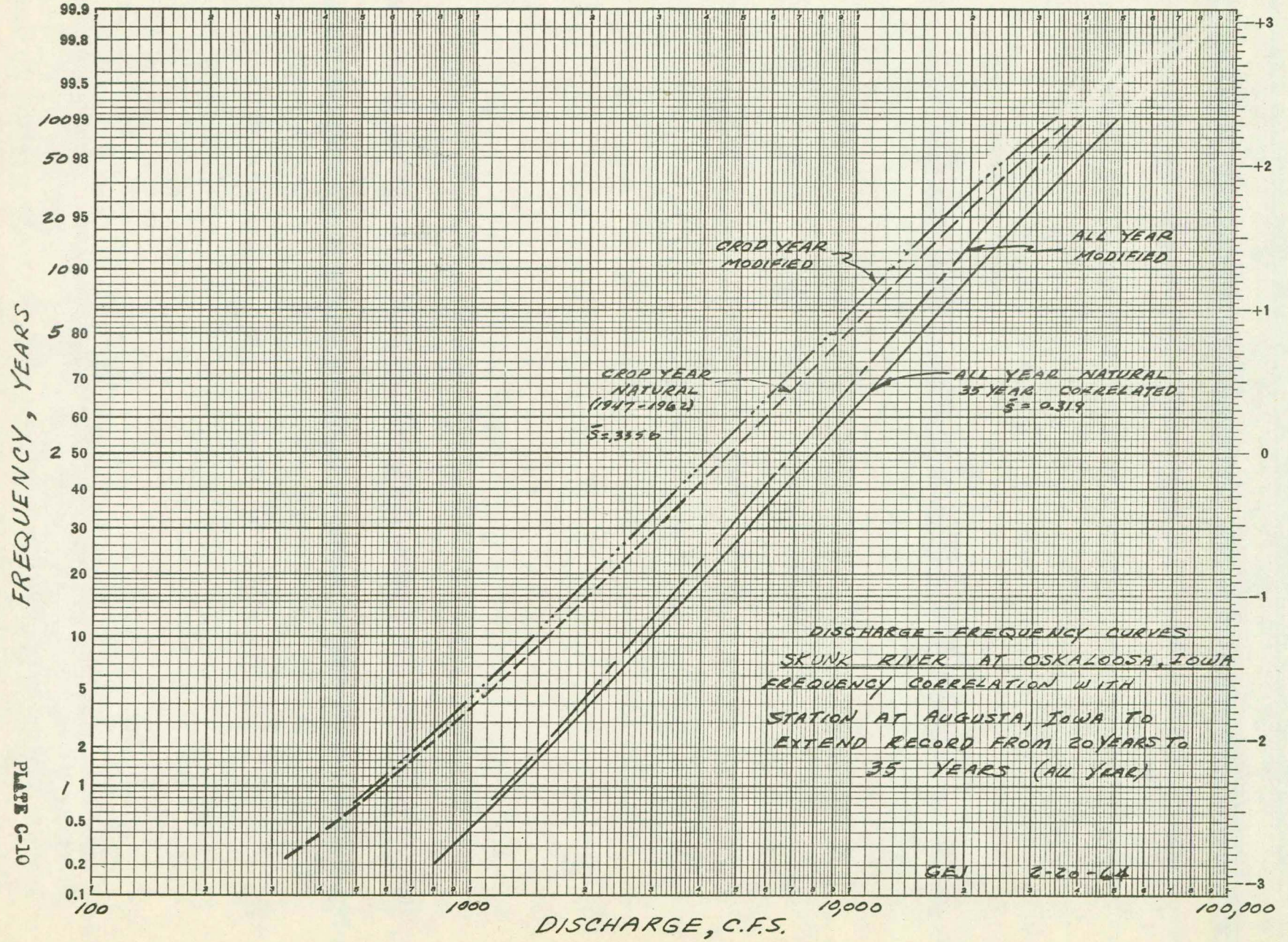

FREQUENCY, YEARS
99.9
99.8
99.5
100 99
50 98
20 95
10 90
5 80
70
60
2 50
40
30
20
10
5
2
1
0.5
0.2
0.1
+3
+2
+1
0
−1
−2
−3
CROP YEAR MODIFIED
ALL YEAR MODIFIED
CROP YEAR NATURAL (1947-1962)
S = 1.3356
ALL YEAR NATURAL 35 YEAR CORRELATED
S = 0.319
DISCHARGE - FREQUENCY CURVES
SKUNK RIVER AT OSKALOOSA, IOWA
FREQUENCY CORRELATION WITH
STATION AT AUGUSTA, IOWA TO
EXTEND RECORD FROM 20 YEARS TO
35 YEARS (ALL YEAR)
GEI 2-20-64
100
1000
10,000
100,000
DISCHARGE, C.F.S.

PLATE C-10

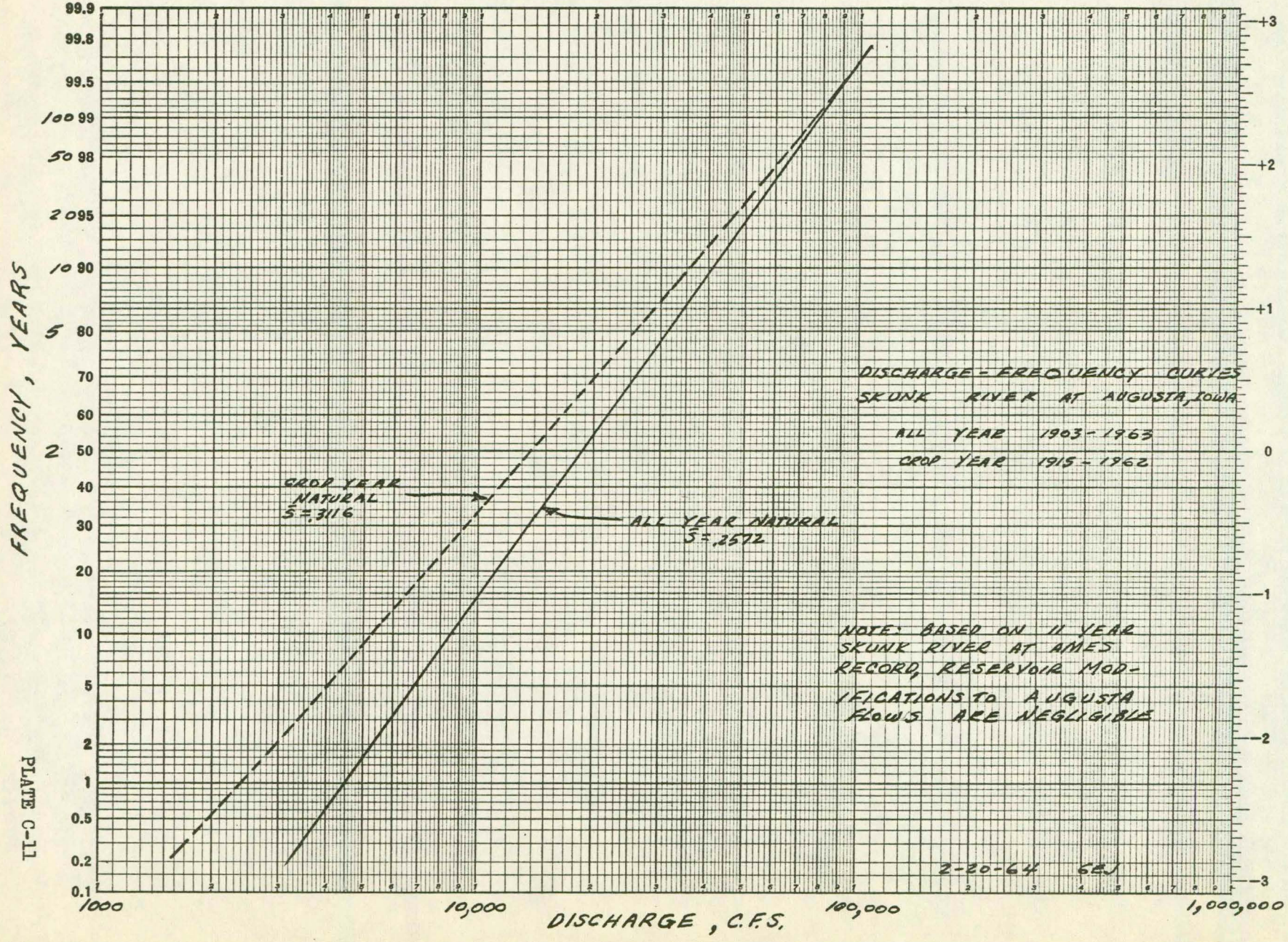

FREQUENCY, YEARS
99.9
99.8
99.5
100 99
50 98
2 95
10 90
5 80
70
60
2 50
40
30
20
10
5
2
1
0.5
0.2
0.1
+3
+2
+1
0
−1
−2
−3
1000
10,000
100,000
1,000,000
DISCHARGE, C.F.S.
DISCHARGE-FREQUENCY CURVES
SKUNK RIVER AT AUGUSTA, IOWA
ALL YEAR 1903-1963
CROP YEAR 1915-1962
CROP YEAR NATURAL
$\bar{S}$ = .3116
ALL YEAR NATURAL
$\bar{S}$ = .2572
NOTE: BASED ON 11 YEAR SKUNK RIVER AT AMES RECORD, RESERVOIR MODIFICATIONS TO AUGUSTA FLOWS ARE NEGLIGIBLE
2-20-64 GEJ

PLATE C-11

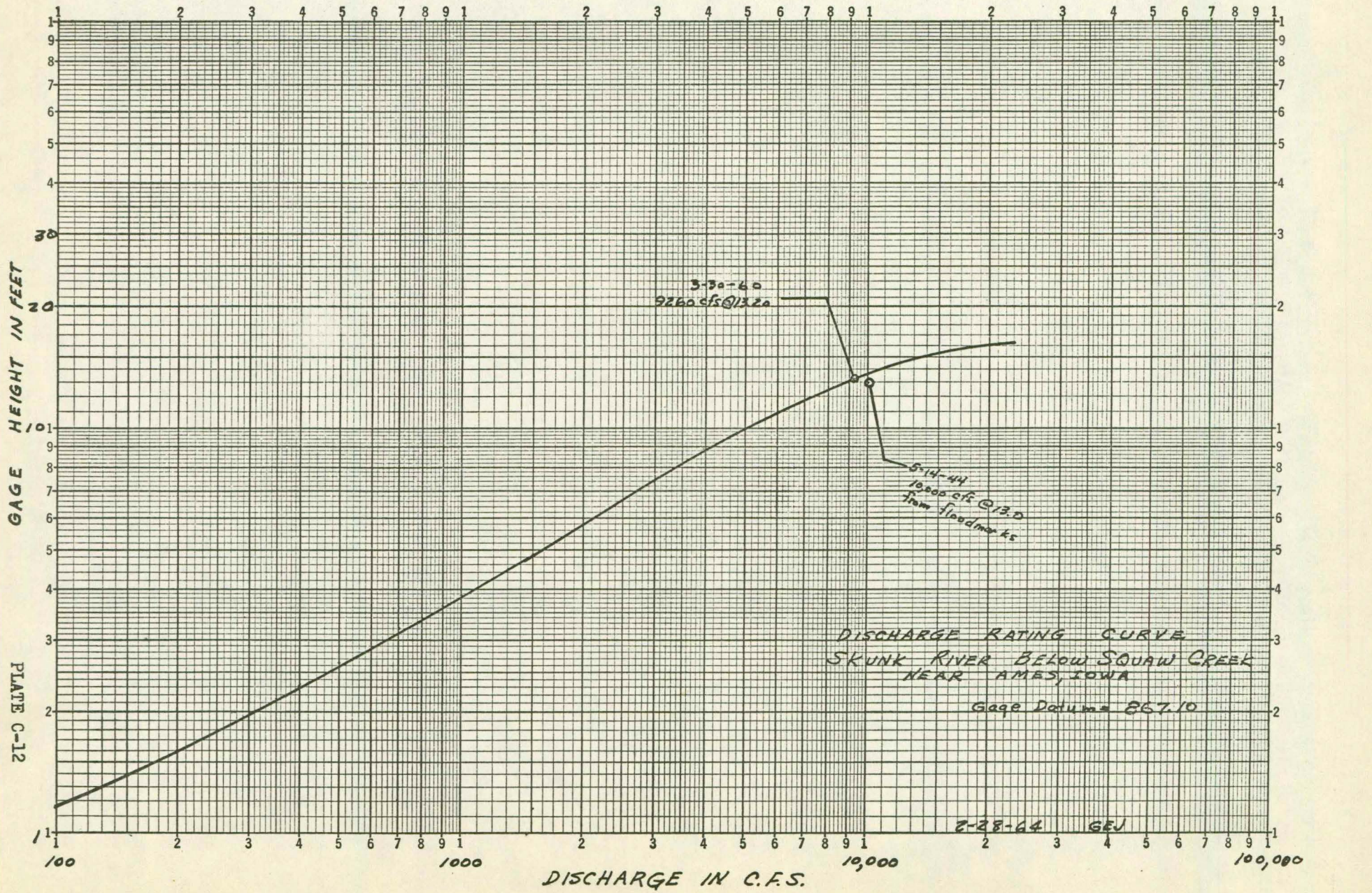

GAGE HEIGHT IN FEET
DISCHARGE IN C.F.S.
100
1000
10,000
100,000
3-30-60
9260 cfs @ 13.20
5-14-44
10,000 cfs @ 13.0
from floodmarks
DISCHARGE RATING CURVE
SKUNK RIVER BELOW SQUAW CREEK
NEAR AMES, IOWA
Gage Datum = 867.10
2-28-64 GEJ

PLATE C-12

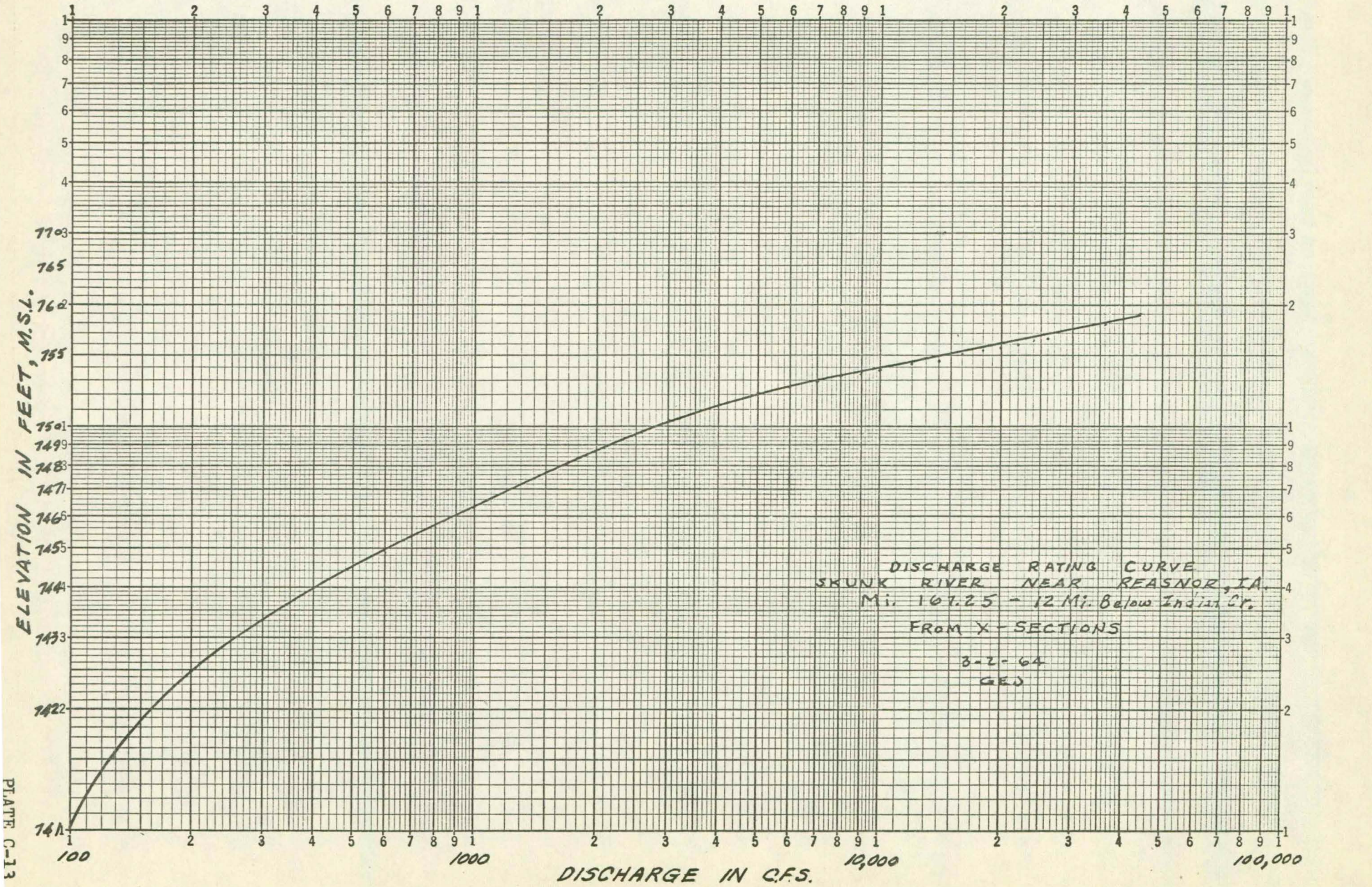

ELEVATION IN FEET, M.S.L.
DISCHARGE IN C.F.S.
100
1000
10,000
100,000
DISCHARGE RATING CURVE
SKUNK RIVER NEAR REASNOR, IA.
Mi. 161.25 - 12 Mi. Below Indian Cr.
FROM X-SECTIONS
3-2-64
GEJ

PLATE C-13

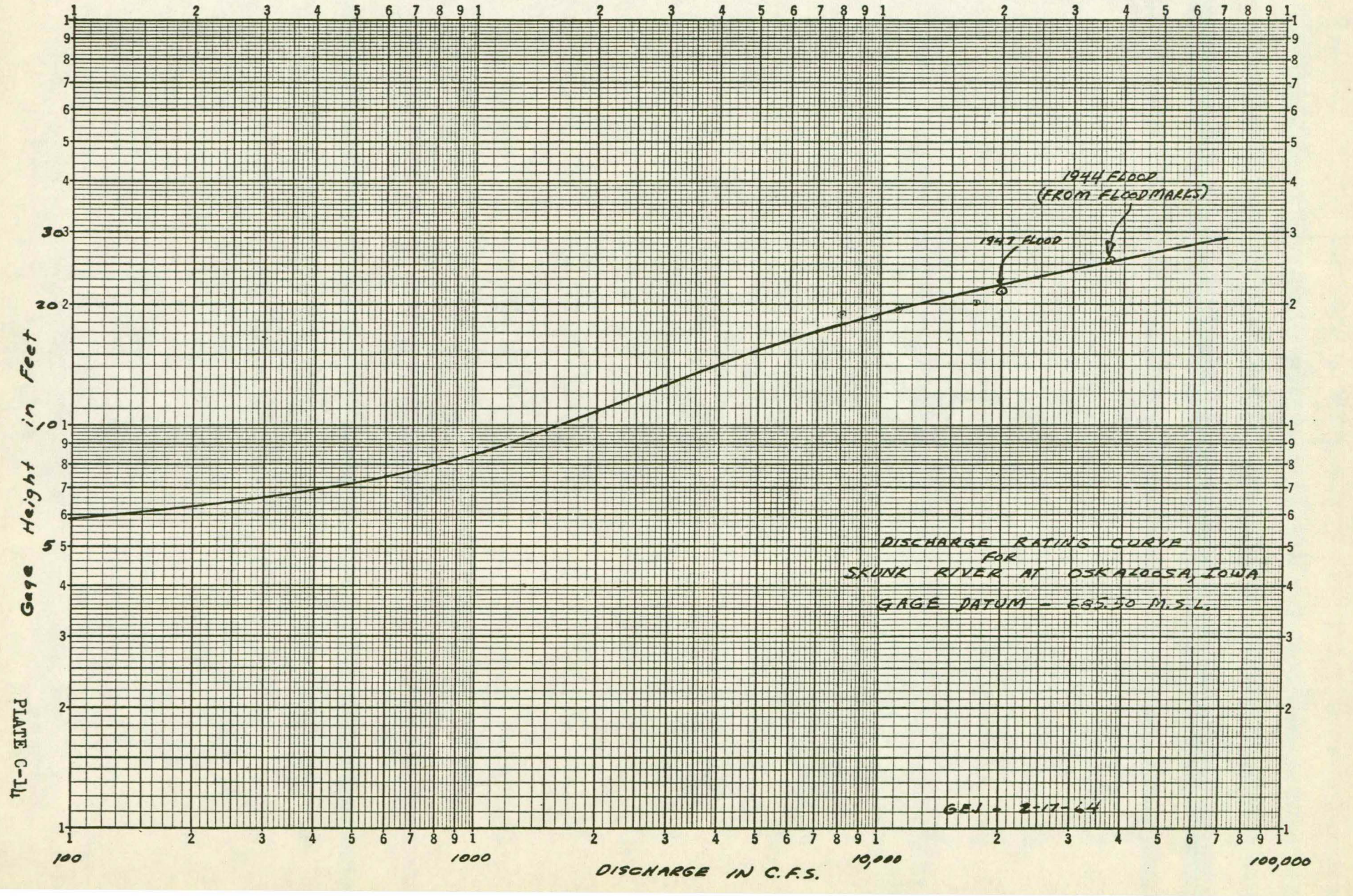

1944 FLOOD
(FROM FLOOD MARKS)
1947 FLOOD
DISCHARGE RATING CURVE
FOR
SKUNK RIVER AT OSKALOOSA, IOWA
GAGE DATUM - 685.30 M.S.L.
GEJ - 2-17-64
Gage Height in Feet
DISCHARGE IN C.F.S.
100
1000
10,000
100,000

PLATE C-114

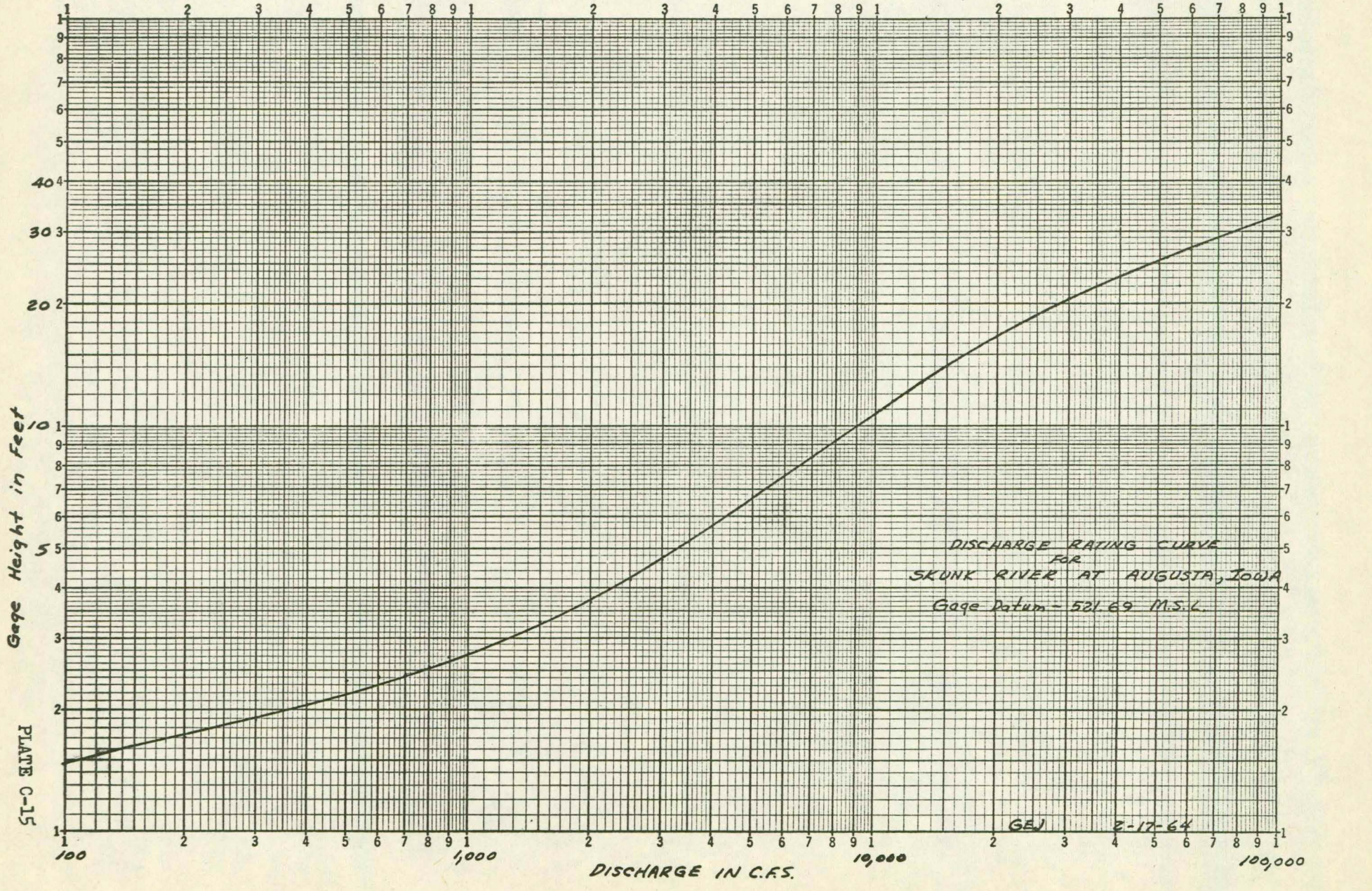

DISCHARGE RATING CURVE
FOR
SKUNK RIVER AT AUGUSTA, IOWA
Gage Datum = 521.69 M.S.L.
GEJ 2-17-64
Gage Height in Feet
DISCHARGE IN C.F.S.
100
1,000
10,000
100,000

PLATE C-15

INTERIM REVIEW OF REPORTS
FOR FLOOD CONTROL AND OTHER PURPOSES
ON THE SKUNK RIVER, IOWA - AMES RESERVOIR

APPENDIX D

REPORTS OF OTHER AGENCIES

U. S. Army Engineer District, Rock Island
Corps of Engineers
Clock Tower Building
Rock Island, Illinois

INTERIM REVIEW OF REPORTS FOR FLOOD CONTROL AND OTHER PURPOSES ON THE SKUNK RIVER, IOWA - AMES RESERVOIR

APPENDIX D
REPORTS OF OTHER AGENCIES

Table of Contents

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
REGIONAL OFFICE
560 Westport Road
Kansas City, Missouri 64111

PUBLIC HEALTH SERVICE
WS & PC Program

October 22, 1964

Your reference:
NCRED-R

Colonel H. B. Coffman, Jr.
District Engineer
Rock Island District
Corps of Engineers, U. S. Army
Clock Tower Building
Rock Island, Illinois 61202

Dear Colonel Coffman:

In your letter of 13 August 1964 you requested that we conduct an investigation to determine the present and prospective needs for water for municipal and industrial uses and for water quality control from the proposed Ames Reservoir on Skunk River in Iowa.

In accordance with the Memorandum of Agreement dated November 4, 1958, between the Department of the Army and the Department of Health, Education and Welfare, relative to the Water Supply Act of 1958 (Title III of Public Law 85-500) and the Federal Water Pollution Control Act of 1956, both as amended by P. L. 87-88, and with the arrangements made at a conference with representatives from your North Central Division Office and the Rock Island District Office, the Iowa State Department of Health, the Iowa Natural Resources Council, and this office, in Des Moines, Iowa, on September 21, 1964, we have carried out a very limited investigation of the projected need for and value of municipal and industrial water supply and water quality control requirements in the Skunk River Basin. The Public Health Service recommends that a more comprehensive study be made of the Skunk River Basin. The results of this preliminary evaluation should be considered provisional until the findings of a more detailed study are available.

Our findings are summarized as follows:

1. The proposed damsites are located two miles north of Ames, Iowa, (Ames Damsite) on the Skunk River, and four miles northwest of Ames, Iowa, (Gilbert Damsite) on Squaw Creek, a tributary to the Skunk River. (See attached Corps of Engineers' map.) (See plate 1 of report.)*

2. The Skunk River extends from the northeast part of Hamilton County to the southeast and joins the Mississippi River at the Des Moines and Lee Counties line. The watershed is outlined on the attached map.

3. A listing of the major municipalities in the Skunk River Basin, with their 1960 population, name of tributary receiving wastes and remarks is also attached.

*This reference added by Rock Island District.

EXHIBIT 1

4. The watershed has adequate ground water supplies of acceptable quality to meet the projected municipal and industrial water requirements through the year 2060, with the exception of future needs for Ames, Iowa.

5. The demand for municipal and industrial water requirements for the City of Ames is projected to reach 20 mgd by 2060. It is estimated that approximately 10 mgd can be obtained from ground water sources. The city's demand is expected to increase to 10 mgd by 2020.

6. The estimated annual value of storage to supply the projected demand in excess of the estimated safe yield of the present source at Ames is $18,000. The value is based on the construction, operation and maintenance costs of a single purpose reservoir in the vicinity of Ames.

7. Ames, Iowa, as projected, will be the major source of treated wastes discharged to the main stem of the Skunk River. (No estimates have been made regarding water quality control need in any of the tributaries.)

8. The total draft-on-storage of 25,000 acre-feet per year above reservoir inflow will be needed for quality control by the year 2060. The year of first need for releases for quality control in the main stem immediately below Ames is estimated to be 1970.

9. The estimated annual value of benefits attributable to storage to provide for streamflow regulation for water quality control is $200,000, based on the construction, operation and maintenance costs of a single purpose reservoir in the vicinity of Ames.

We appreciate the opportunity afforded by your request and trust that the above comments regarding the Ames Reservoir project will fulfill your immediate requirements. If we can be of additional assistance, feel free to call upon us.

Sincerely,

Herbert C. Clare

HERBERT C. CLARE, P.E.
Regional Program Director
Water Supply and Pollution Control

Water Supplies and Water Pollution Control Facilities
Skunk River Basin

Data Supplied by the Division of Public Health Engineering
State of Iowa

Community	1960 Population	Tributary	Remarks
Ames	27,003	Skunk River	Includes University and Animal Disease Lab.
Baxter	681	Prairie Creek	
Brighton	724	Walnut Creek	
Colfax	2,331	Skunk River	
Danville	579	Long Creek	
Ellsworth	493	Skunk River	No sewers, turkey processing plant
Grinnell	7,367	Sugar Creek	
Huxley	486	Skunk River	
Jewell	1,113	Skunk River	
Kellogg	623	North Skunk River	
Keota	1,096	Dutch Creek	
Lynnville	411	North Skunk River	
Maxwell	773	Rock Creek	
Melbourne	517	North Skunk River	
Montezuma	1,416	Moon Creek	
Mt. Pleasant	7,339	Saunders Creek	Population includes Mental Health Inst.
M. H. Institute	1,500	Creek	Skunk River Water Supply
Nevada	4,227	W. Br. Indian Cr.	
New London	1,694	Mud Creek	
New Sharon	1,063	Dry Creek	
Newton	15,381	Tributaries	Three Plants
Oskaloosa	11,053	Creek	6500 P.E. to Skunk
Pella	5,198	Creek	2500 P.E. to Skunk
Prairie City	943	Calhoun Creek	
Roland	748	Bear Creek	
Signourney	2,387	North Skunk River	
Stanhope	461	Squaw Creek	
Storm City	1,773	Skunk River	
University Park	569	Spring Creek	Primary treatment only
Washington	6,037	W. Fork Crooked Cr.	
What Cheer	956	Coal Creek	
Williams	490	Skunk River	
Winfield	862	E. Fork Crooked Cr.	

Unless noted under "Remarks," all municipalities have well supplies and secondary type of sewage treatment.

UNITED STATES
DEPARTMENT OF THE INTERIOR
Bureau of Outdoor Recreation
Lake Central Region
15 Research Drive
Ann Arbor, Michigan 48103

DEC 1 1964

District Engineer
U. S. Army Engineer District, Rock Island
Corps of Engineers
Clock Tower Building
Rock Island, Illinois 61202

Dear Sir:

This report, The Possibilities and Needs for Recreation at the Proposed Ames Reservoir, Skunk River, Iowa, was prepared under basic authority provided in P. L. 88-29 (88th Congress, Sec. 20) approved May 28, 1963, and in reply to your letter request of August 14, 1964.

INTRODUCTION

The purpose of this report is to assess the potential recreation visitation and benefit which could accrue from the development of the proposed Ames Reservoir project on the Skunk River, Iowa. This preliminary report considers findings and engineering data provided in the Ames Reservoir, Skunk River, Iowa, Special Report issued in May 1964 by the U. S. Army Engineer District, Rock Island, and information from subsequent correspondence with your office.

The study was initiated with the understanding that immediate action on the project is required to resolve a problem of funding for construction of Interstate 35 at a suitable elevation above the project flood control pool. It is understood that only preliminary engineering data is currently available.

GENERAL DESCRIPTION

The proposed Ames Reservoir site is located on the Skunk River in Story County, Iowa, about three miles northeast of Ames. The impoundment is primarily designed for flood control purposes with possible low-flow augmentation, water quality control, and water supply.

EXHIBIT 2

Available pool data as provided by your office are as follows:

	Elevation	Surface Area
Conservation pool	928 feet m.s.l.	630 acres
Conservation pool with low flow augmentation storage	---	1,000 to 1,200 acres
Flood Control pool	960 feet m.s.l.	3,250 acres

It is assumed that a seasonal pool is not feasible because of the flood threat that occurs during the summer months.

The economy of the area is mainly agricultural, while the nearby town of Ames is the location of Iowa State University, and has a service economy. The lands surrounding the project are high quality agricultural lands.

The population of the 25-mile zone of influence, according to the 1960 census, was 119,929. This zone of influence is composed of four counties including Story, Hamilton, Boone, and Hardin.

NEED FOR RECREATION DEVELOPMENT

At the present rate of growth, the population within the 25-mile zone of influence is expected to increase to 123,500 by 1970 and 136,900 by the year 2000. This anticipated rise in population reflects a potential increased demand for recreational opportunities. Only one highly developed outdoor recreation area presently exists within the zone of influence. This area, Ledges State Park, is located on the Des Moines River and had a reported attendance of over 446,000 in 1963.

Present access to the proposed project impoundment area is facilitated by two major highways in the state. East/West US 30 and North/South US 69 are presently Iowa's most heavily traveled highways. Several interchanges are planned to provide access to the project area from Interstate Route 35, but definite locations are not known at this time.

PLAN OF RECREATION DEVELOPMENT

It is anticipated that day-use activities, i.e., picnicking, swimming, and boating, would comprise the major recreational use of the proposed Ames Reservoir. Camping facilities should, however, be developed to accommodate a portion of the increasing numbers of participants in that activity. Several areas adjacent to the impoundment and tailwaters of the dam would support these activities.

Initial development should include both day-use and overnight facilities. Provision should be made for the future expansion of these facilities to meet public demand.

During construction of the dam, care should be taken to preserve the natural quality of the hillsides adjacent to the damsite. These areas would provide excellent overlooks and picnic sites. The wooded area just below the dam would provide quality camping sites. This could be integrated with any possible fisherman use of the tailwater area.

Consideration should be given to limiting horsepower of watercraft on the project waters. The Saylorville reservoir project, just west of the zone of influence, would be of sufficient size to accommodate boats of any horsepower.

PROJECT EVALUATION

The greatest recreation use of the Ames Reservoir would originate from the resident population of Ames and Iowa State University, but the opening of Interstate 35 will considerably augment this service population by providing ready access from Des Moines.

Des Moines, a city of 208,982 people, lies about 33 miles from the proposed Ames Reservoir. Although outside the zone of influence, a city of this size could be expected to exert considerable recreation demand. However, the 5,500 acre Saylorville Reservoir, currently under construction by the Corps of Engineers only a few miles from Des Moines, is expected to satisfy much of this demand and possibly draw substantially from the zone of influence of the Ames Reservoir.

The suspended sediment in this impoundment is expected to create low water-quality conditions. The sediment entrapment of the Ames Reservoir is estimated by the Corps at 4,225 acre feet during a 50-year period. This amount of sediment could substantially fill the proposed 630 acre conservation pool during the life of the project.

It is considered that the planned Interstate highway structure through the project area could detract from the aesthetic value of the reservoir. Also, the nearness of the impoundment to the Interstate route could possibly create a safety hazard to highway users by distracting the attention of the drivers. However, the construction of a roadside rest area overlooking the conservation pool would capitalize on the recreation aspects of the reservoir.

At this time certain pertinent project information and operational data are not available. Therefore, the findings of this report are qualified on the following assumptions.

1. Interstate 35 would traverse the proposed reservoir site as planned.

2. Adequate access would be provided to the project from Interstate 35.

3. Sufficient lands would be acquired to enable proper recreation development.

4. Adequate facilities would be constructed to accommodate the estimated visitation.

Considering Iowa State Park visitations, service population and project features, the following estimates of visitation and project benefits have been determined. They do not include single purpose visitations of hunting and fishing.

Period Period	Estimated Annual Visitation	Estimated Annual Benefits	Cost of Recreation Facilities
Initial (Years 1-5)	110,000	$ 82,500	$368,000
Ultimate (Years 6-35)	180,000	$135,000	$621,000

It is anticipated that the estimate of 180,000 annual visits would hold from 35 years after project completion throughout the life of the project with some variation dependent upon the amount of sedimentation and its effects on recreation activities and independent of possible development of other recreation facilities in the immediate vicinity.

In accordance with the methods set forth in Senate Document 97, Supplement No. 1, "Evaluation Standards for Primary Outdoor Recreation Benefits," a value of $0.75 per visit to the Ames Reservoir has been assigned.

The initial cost of facilities for the Ames Reservoir project would be roughly $368,000 which would provide one beach development and one boat ramp, 50 camp units, and 120 picnic units. The ultimate cost of facilities would be about $621,000 which would provide another beach development and boat ramp, 25 additional camp units, and 80 additional picnic units. This estimate does not include costs of land acquisition which would be determined as more detailed planning is undertaken.

If any or all of the following conditions can be implemented then a higher visitation would be expected and a higher value per visit could be assigned.

1. Partial removal of the silt load of water before it reaches the impoundment

2. Stabilization of the pool level during the recreation season.

VIEWS OF OTHER INTERESTS

In the preparation of this report, discussions were held with both the U. S. Army Engineer District, Rock Island, and the Iowa State Conservation Commission.

The Iowa State Conservation Commission indicated no active interest in the administration of the general recreational aspects of the proposed Ames Reservoir at the present time.

A preliminary draft of this report was submitted to the Bureau of Sport Fisheries and Wildlife for comment. They agreed with the general approach and conclusions. It was further indicated that they would prepare a report on the fish and wildlife aspects of the project.

Although no official contact was made with Iowa State University at Ames, it is possible that they would be interested in developing a recreational plan for the proposed project.

CONCLUSIONS AND RECOMMENDATIONS

It is concluded that:

The proposed Ames Reservoir project lies in an area having few water-oriented recreational opportunities. Proper development of day-use and camping facilities at this project would allay some of the need for these activities although full utilization would be limited by possible sedimentation and pool level fluctuation.

It is recommended that:

1. All interested agencies be kept informed of the project plans to provide proper land use zoning and area planning.

2. Sufficient lands be acquired to insure balanced recreational development.

3. Adequate facilities be constructed to accommodate the estimated visitation.

4. The portion of Interstate 35 traversing the project be designated as a reduced speed zone for safety purposes.

5. A scenic turnout and/or rest area be constructed on the Interstate overlooking the conservation pool, if feasible.

6. The impoundment be zoned for low horsepower boating use.

7. The construction of upstream silt-retaining structures be considered to increase the quality of the impounded waters and the recreational life of the project.

8. The Bureau of Outdoor Recreation be kept informed as further studies and plans are developed on the project, so that further recreation planning can be provided as needed.

The Bureau appreciates the opportunity to present these comments. The report should be regarded as preliminary and subject to modification as further pertinent information becomes available.

Sincerely yours,

Roman H. Koenings

Roman H. Koenings
Regional Director

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

405 Iowa Building
Des Moines, Iowa
October 9, 1964

Col. Howard E. Coffman
District Engineer
Corps of Engineers
Clock Tower Building
Rock Island, Illinois

Dear Colonel Coffman: Ref. NCRED-R

A letter by Mr. J. H. Peil, Acting District Engineer, dated September 1, 1964 pertaining to the Ames Reservoir and indicating a need for studies of irrigation possibilities was received at this office and further discussed with members of your staff on September 8, 1964. Based upon very incomplete and preliminary studies conducted since that time we have compiled information as set forth below. We hope this will be of value to you in development of the plan.

1. We have assumed in this analysis that the Ames Reservoir is only one of several that would be required to control floods on the Skunk River with the next large one located downstream on Indian Creek, a tributary in Jasper County. It was assumed that such a reservoir on Indian Creek could supply needed irrigation water storage for the Skunk River bottomland area lying downstream from that point and that the Ames Reservoir would supply storage only for lands lying upstream from Indian Creek.

2. A study of your Special Report of the Ames Reservoir and of various soils maps and photos of the area lying downstream from the Ames reservoir site to Indian Creek indicates that there are about 38,000 acres of bottomlands and adjacent rather flat terrace lands where irrigation of farm crops could be considered. About ten percent of these lands are heavy silty clay loam or denser throughout, 23 percent are overwash, sandy, or variable texture alluvial fans and terraces, both of which are used mainly for crops, 17 percent are occupied by channels, meandered land or idle land not now cultivated, and 50 percent are silt loams regularly used for crop production of corn, soybeans, grain, etc.

EXHIBIT 3

3. A study of the various specific soil types, their locations in the valley, and their adaptability to land leveling or grading for irrigation indicates that 20,000 acres of these lands could possibly be irrigated.

4. Research studies have been carried out during the past several years on bottomland soils in the Squaw Creek and Skunk River Valleys near Ames and have provided some information concerning the problems and feasibility of irrigating these soil types. The results indicate that the crop yield increases obtained during this period have paid for the additional costs of irrigation. However, data also indicate that incentives for irrigation under such present expected yields and prices received for corn and other grain crops at this time are not such as to make the practice a highly desirable and recommended one for most farmers.

5. During the past several years the number of water permit holders for irrigation purposes has remained about constant in the Skunk River Valley. Approximately the same number of permits have been relinquished during that period as have new permits been issued. About 340 acres are irrigated annually. The immediate past and present demand for irrigation permits has thus been rather low and the acreage of lands being irrigated has remained about constant.

6. The Skunk River Valley is underlain by rather extensive sand and gravel beds. Wells for irrigation can be developed at many locations. Test wells would be needed to locate the water bearing sand and gravel beds that would be adequate for this purpose. Some wells have been developed and the water supply from them has been quite adequate. Data concerning total amounts of well water for irrigation purpose in this area is not available. It is expected, however, that much of the demand for irrigation water in the valley could be met through pumping from wells and from the Skunk River.

7. If we assume that 20,000 acres of land below Ames Reservoir were to be irrigated, then an estimated delivery of about 20,000 acre-feet of water should be planned for. Losses in transit, storage, etc. would perhaps indicate a need for storage of 25,000 to 30,000 acre-feet of water for irrigation.

8. It appears doubtful that water from such storage would be used for the irrigation purpose for quite some time in the future. This estimate is based on the experience to date in the area. Water from wells or from the Skunk River itself has been available and has been put to only minor and limited use.

9. In order to cost-share in the installation of storage for irrigation water some form of State enabling legislation would be required to permit the organization of an irrigation district with taxing and other authorities. It is doubtful that support would be given to organization of such a district in this area were enabling legislation passed.

10. Considerable improvement in yields in these bottomland areas would be made possible by land leveling and grading for drainage after the areas are protected from floods. This practice would need to be installed on the lands prior to installation of an irrigation system.

11. Our analysis, as pointed out above, indicates an irrigation potential in the valley below the Ames Reservoir. However, it appears that the demand for irrigation water from reservoir storage, at the present time, is very limited.

12. We did not investigate the adverse effects of storage of irrigation water in the Ames Reservoir. Our general knowledge of the topography of the upstream area indicates that such additional storage of water at the site may inundate or otherwise damage significant areas of lands upstream from the site.

Further technological advances in the desirable relationships of fertilizers, plant populations, varieties and prices no doubt in the future will make such projects highly feasible. However, based on information that is presently available we would doubt that local people will now encourage the provision for storage of irrigation water in Ames Reservoir and organize to pay for or amortize these costs prior to the time that the benefits are received. We therefore are unable to recommend at this time that storage of irrigation water be provided for in the plan.

Sincerely yours,

Frank H. Mendell
State Conservationist

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
1006 WEST LAKE STREET
MINNEAPOLIS, MINNESOTA 55408

In reply refer to:

RB

December 3, 1964

District Engineer
U. S. Army Engineer District
Rock Island
Clock Tower Building
Rock Island, Illinois

Dear Sir:

Your letter of September 8, 1964, requested our evaluation of the effects on fish and wildlife of the Ames Reservoir, Iowa project. This project was originally scheduled for study in F.Y. 1966. We understand that the request for accelerated submission of our report is based on a special need for completion of this project report by your District and Division Offices by January 1, 1965.

This special report, prepared under the authority and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) has been reviewed and concurred in by the Iowa Conservation Commission.

Your flood control report of March 30, 1951 of the Skunk River indicated that Ames Reservoir was economically justified. However, the report was later returned by the Board of Engineers for Rivers and Harbors and the project was not authorized.

In 1962, the effects of planned Interstate Highway #35 on the proposed Ames Reservoir project were considered by the Iowa Natural Resources Council, the Iowa Highway Commission, the U. S. Bureau of Public Roads, and by your agency. The planned highway would traverse three miles of the reservoir area, and require raising of the roadway above reservoir level. Estimated cost of such modification would be about $1,000,000 if done prior to reservoir construction. This represents a saving of $1,500,000, compared to the cost of raising the road grade after reservoir construction. Early construction of Interstate Highway #35 is planned. This will require early determination regarding necessary modifications and funding arrangements. Highway modification costs are expected to be assumed as a Federal cost, but chargeable to the Ames Reservoir project, inasmuch as the highway is already planned and reservoir construction is not yet authorized.

The only previous report on the Upper Skunk River project by this Bureau was our Preliminary Evaluation Report on Fish and Wildlife Resources in Relation to the Flood Control Plan for the Upper Skunk River, Iowa, Upper Mississippi Basin. That report was issued March 29, 1951. We understand

EXHIBIT 4

that project plans remain essentially the same as described in our 1951 report. However, additional storage is being considered in the present plan. This is to provide for increasing minimum flows downstream from the dam. We have used your Ames Reservoir-Skunk River, Iowa Special Report of May 1964 as the primary source of project information for preparation of this report. In addition, we have consulted freely with members of your staff regarding the project. This report supplements and updates our 1951 report. Special consideration is given to anticipated effects of the highway crossing upon associated fish and wildlife resources.

DESCRIPTION OF THE AREA

The Skunk River Basin extends from central Iowa southeasterly to the Mississippi River valley near the southern border of the state. The river drains 4,324 square miles. It is 264 miles long and its basin averages 24 miles in width. The headwaters elevation of 1,200 feet declines to 518 feet elevation at the river mouth. The valley is narrow in the upper reaches downstream to the confluence with Squaw Creek, near Ames. Downstream from that point the valley widens. Since the early 1900's the middle reaches of the once meandering streams have been confined to a straightened channel, constructed by numerous drainage districts under provisions of State law.

The basin is underlain with shales, sandstone, limestone, and coal of the Pennsylvanian series. The economy of the basin is based largely on agriculture. Productive loess and alluvial soils support corn, oats, soybeans, and hay as principal crops. About 63 per cent of farmland in the upper basin is cultivated; 31 per cent is pasture and woodlots, and the remaining land is used for other purposes. According to the 1960 census, the only communities of over 5,000 in the upper basin are the City of Ames with a population of 27,003, and Newton with a population of 15,381. About one-third of the basin population is rural.

Developed public recreational areas in the basin are limited to five state parks, four of which are located in the lower basin below Oskaloosa (population 11,053). An undeveloped site is maintained by the Story County Conservation Board along the Skunk River in the proposed reservoir area. It provides public access to the stream in the upper reaches.

DESCRIPTION OF THE PROJECT

The proposed project features construction of Ames Reservoir on the Skunk River near Ames, Iowa. That reservoir and the proposed Gilbert Reservoir on a tributary, Squaw Creek, are designed to alleviate downstream flooding losses to roadways and flood plain and agricultural lands. Ames reservoir would include storage for water supply, recreation, pollution abatement and fish and wildlife.

Enlargement and straightening of the Skunk River channel is not being considered in this project as a flood control method. The Iowa Conservation Commission has strongly urged heavier emphasis on storage and less emphasis on channelization for flood control purposes. Supplementary flood control

for the upper basin is contemplated by reservoir construction on small tributaries between the Ames damsite and Indian Creek, about 40 miles downstream. These reservoirs and the Gilbert Reservoir would not have permanent pools.

Engineering data for the Ames Reservoir project is summarized in Table 1.

Table 1. Engineering Data - Ames Reservoir, Iowa 1/

	Elevation (ft.msl)	Capacity (acre-ft.)	Surface (acres)	Shoreline (miles)	Stream Length (miles)
Maximum flood control pool (spillway crest)	960	63,500	3,250	53	13.7
Conservation pool	928	5,600	630	16	7.3
Outlet works (invert elevation)	900	--	--	--	--

1/ The above specifications may be modified to include additional conservation pool storage of up to 25,000 acre-feet to provide the low-flow releases of up to 40 c.f.s. recommended by the Public Health Service.

The Ames Reservoir dam will consist of a rolled-earth fill, situated at mile 220.6. It will have a crest height of 85 feet above the streambed and a crest length of 1,260 feet. The reservoir size will be limited by the location of Story City, at about mile 232.0.

The outlet will consist of a gated concrete conduit with a 7 foot diameter. Three 36 inch by 60 inch slide gates will be used to maintain a low-flow of 10 c.f.s. These specifications will be modified as necessary, should minimum low flows be increased. The saddle-type spillway will be cut through rock on the left bank. The upper control section will be concrete, with a weir 230 feet wide. Spillway flows will pass through the control section, then over rock surfaces to the river channel below the dam.

FISHERY

Without the Project

The Skunk River and its tributaries in the project area are fertile, but sluggish streams. They are frequently turbid, particularly after rainy periods. The mainstream is characterized by long, shallow pools and few riffle areas. Flooding is frequent in spring and early summer, and low flows prevail during late summer and fall months. The streambanks are steep and are subject to severe undercutting. Aquatic vegetation is limited but streambanks generally are covered by dense woody plant growth. The flood plain is devoted largely to corn and alfalfa production.

The Skunk River in the project area supports moderate fishing pressure, primarily from local residents. Important species in the catch include channel catfish, bullheads, suckers, carp, crappies, and sunfishes. Occasionally, smallmouth bass are caught. Deterioration of stream habitat in recent years has resulted in serious decline in the numbers of this desirable game fish.

Most sport fishing is in the spring months, when flows are high. Low summer and fall flows prevail and the relatively low catch rate attracts fewer anglers during these periods. High tubidity is detrimental to fishing, but other types of pollution are not a problem.

Fishing pressure in the 20-mile reach of the Skunk River between Ames and Story City is concentrated at the State public access area 2 miles above the damsite and along a reach several miles downstream from the damsite. Fishing pressure is also concentrated at the several bridges crossing the Skunk River above the damsite.

With the Project

The project will have a decided impact on fishery resources. Approximately 7 miles of the stream will be inundated by the 630-acre permanent pool. Lesser losses will be sustained by temporary inundations of one and one-half miles of stream above the conservation pool. Stream losses would be proportionately higher if a larger conservation pool is included in the project. However, stream fishery losses will be more than offset by a heavily used reservoir and tailwater fishery.

The fertile Skunk River basin will provide the nutrients for a productive sport fishery. On the other hand, anticipated heavy siltation will lower the fishery potential of Ames Reservoir. With intensive management, rough fish populations can be kept under control and desirable bass, bluegill, crappie, sunfish and channel catfish populations maintained at levels attractive to anglers.

Effective fishery management of project waters will be facilitated if a low-level outlet is provided. This will allow periodic drawdown, if needed for rough fish control. Complete eradication of all fish from waters upstream from the damsite shouldbe accomplished before dam closure so that rough fish populations will be at a minimum when game fish are introduced in the new reservoir.

Maintenance of a minimum discharge of 10 c.f.s. from the reservoir will improve the stream fishery below the dam. Considerably higher benefits will accrue if that discharge is increased. Present flows frequently drop below 10 c.f.s. during dry summers. Improvement in volume and quality of flows in downstream stretches of Skunk River will largely offset losses to the stream fishery in the impoundment area.

Ames Reservoir will be located within an hour's drive of four cities--Des Moines, Marshalltown, Boone, and Ames. Many anglers living in Boone and Des Moines are expected to fish in planned Saylorville Reservoir to be

located on the Des Moines River about 20 miles west of Ames Reservoir. However, Ames Reservoir will be favored by anglers living in nearby Ames and the area eastward to Marshalltown. Other lake-type fishing in this area is limited principally to Little Wall Lake, 10 miles to the north of Ames Reservoir site.

The net annual fishery benefit attributable to the Ames Reservoir is $29,600 with the 630 acre conservation pool. The annual fishery value will be at least doubled if the conservation pool is increased to 1,800 acres (elev. 945).

WILDLIFE

Without the Project

The quality of wildlife habitat in the Ames Reservoir area is well above average for this part of Iowa. The project area includes considerable flood plain, with an excellent dispersion of woody cover, herbaceous vegetation, pasture and agricultural land along this section of the Skunk River. Most of the valley floor is devoted to corn production, which is well interspersed with forage crops and grassland. Timber and brush is concentrated along roadways, stream courses, and on rough terrain in the valley or on upland slopes. Grazing of woodlands by livestock is a common practice, but sizable areas of timber are protected by fence.

Principal upland game species are fox squirrels, cottontail rabbits, raccoons, red foxes, and opossums. Bobwhite quail and ring-necked pheasants are present but are not plentiful. Mourning doves are moderately abundant, but these birds are not hunted in Iowa.

Squirrel hunting is the most popular sport furnished by wildlife in the project area. Hunting raccoons and red foxes with dogs is a popular sport practiced by a few area hunters. Pheasants, bobwhite quail, and rabbits provide only limited hunting.

The most important fur animals in the reservoir area are muskrats, mink and beaver. Several beaver colonies are located along the mainstream. Bank denning muskrats are common. Trapping is mostly by resident farm boys who tend short traplines. The catch is primarily muskrats, but occasionally mink are taken.

White-tailed deer are the only big game animals present. Deer have increased to the point that an annual season for hunting with shotgun or bow and arrow was initiated in 1953. A deer herd estimated at 50 animals supports considerable hunting in the project area.

A few wood ducks nest in timbered areas along the streams. The mainstream and several flooded gravel pits in the impoundment area provide resting areas for spring and fall migrants, including blue-wing teal, mallards, and pintails. Occasionally, ducks feed in the harvested corn fields along the valley floor and bordering uplands.

With the Project

Construction of Ames Reservoir will result in the complete loss of 630 acres of excellent wildlife habitat. An additional 330 acres will be significantly reduced in value because of frequent inundation. Losses will be proportionately higher if the elevation of the conservation pool is raised above elevation 928, in order to provide additional storage for downstream releases. Upland wildlife, fur animals, big game and small game will suffer losses directly proportional to the extent of terrestrial habitat flooded.

Waterfowl will benefit from Ames Reservoir. However, these benefits will not compensate for losses to terrestrial forms of wildlife.

Bottomlands in Skunk River valley downstream from the damsite for approximately 20 miles will be fully protected from flooding, with the project. Stream sections below that point will have only limited protection. Although flood protection of downstream bottomlands may appear to be advantageous to wildlife, change in land use of those areas will result in overall losses, with the project. Landowners will begin intensively cropping lands which are not now being farmed. Much of this land--excellent flood plain wildlife habitat--exists only because it is subject to periodic flooding. With the project, a considerable loss of herbaceous and woody plant cover is expected to occur in these downstream areas. That loss will be especially detrimental to wildlife species dependent upon brush and timber-covered bottoms.

Wildlife losses from anticipated effects of proposed Interstate Highway 35 will be caused by direct loss of about thirty acres of bottomland habitat, due to locating the highway along three miles of flood pool area. Other losses will result from adverse effects of high-speed traffic through the project area. The highway will lower the wildlife management potential of the project substantially, since it will bisect the most valuable portion of the project area undesirable from a wildlife management standpoint. High-speed traffic will be heavy and will jeopardize deer moving across the highway. Upland game hunting and observation of wildlife in a natural setting will be adversely affected by the highway.

Intensive management of those lands which will be periodically inundated above the normal pool will be necessary. Only in this manner can carrying capacities be maintained high enough to offset the project-occasioned losses. Any significant increase in the size of the conservation pool area should be accompanied by a comparable increase in the size of wildlife management area to be administered by Iowa to mitigate terrestrial wildlife losses.

Ducks will be attracted to the reservoir area during spring and fall migration periods. Censuses on the adjoining Des Moines River indicate that spring use of Ames Reservoir by migrant waterfowl will likely be several times as heavy as fall use. Natural aquatic plants will be in short supply, but waste grain from adjacent farming areas will provide ample feed for several species of ducks and geese. Wood ducks will continue to breed in the project area if suitable timber remains available. In addition, teal and possibly other

waterfowl can be encouraged to nest in the project area if subimpoundments are developed for that purpose. Development of several potential waterfowl sites, including Bear Creek and Keigley Branch, should be considered during preconstruction planning.

Construction of the project is not expected to result in any important net change in the population of aquatic fur animals. However, the loss of habitat for terrestrial fur animals will result in an overall reduction in numbers of this group.

In summary, overall losses to wildlife are anticipated, unless adequate provision is made for replacement lands for wildlife management, with public access to suitable project areas for hunting or general enjoyment of the wildlife. If waterfowl habitat is created and upland areas are made available for intensive management by the Iowa Conservation Commission, wildlife losses will be satisfactorily mitigated. Beyond this, the development of subimpoundments for waterfowl would result in net benefits.

DISCUSSION

Construction and operation of the Ames Reservoir will result in a substantial loss of upland game, big game, and terrestrial fur animal habitat. That loss would be proportionately greater should the 630-acre conservation pool be significantly increased in size in order to provide increased minimum downstream flows.

Land use on the 10,000 acres which would be protected from floods below Ames Dam can be expected to change, to the detriment of existing good wildlife cover. The extent of that loss over the long term is difficult to measure, but is expected to be significant.

Use of the area by waterfowl will be increased after impoundment. A sizable body of water in an agricultural area near the paths of migrating ducks and geese will attract several waterfowl species. Development of subimpoundments to provide breeding and nesting sites would further encourage waterfowl production. Lack of open water during much of the winter and the limited size of the reservoir will discourage wintering of waterfowl in the project area.

Increased waterfowl use will not offset project-incurred losses to terrestrial wildlife. Those losses can best be resolved by intensive management by the Iowa Conservation Commission of suitable project lands, under the terms of a General Plan.

Ames Reservoir will create a fishery which will be well utilized. In the immediate project area, lake-type fishing is limited to a few farm ponds and Little Wall Lake, which is located about 10 miles north of Ames. Local residents are expected to make heavy use of Ames Reservoir and the tailwater area below the dam, even though planned Saylorville Reservoir on the nearby Des Moines River will satisfy much of the local sport fishing needs.

Soils in the basin are productive and the project waters should be rich in nutrients. The reservoir waters may be seasonally turbid but this reservoir is expected to support large populations of the usual species of warmwater fishes common to central Iowa waters. Settling out of most silt carried into the reservoir will assure relatively clear downstream releases. An

intensive fishery management program will be needed to control undesirable fish and to assure maintenance of an attractive sport fishery.

Significantly increasing the size of the conservation pool will have little effect on the composition of its fish population, but the greater volume and surface area will support more fish and correspondingly heavier fishing pressure. Most of this increased fishing would be in the reservoir, but unstraightened downstream reaches also would benefit significantly.

Selective clearing of woody vegetation in the reservoir area should be included in project plans, to insure attainment of the highest fish and wildlife potentials. The possibilities of leaving designated areas such as reservoir bays or arms uncleared should be considered. In addition to providing an attractive place for fishing, standing timber is frequently attractive to waterfowl.

Loss of stream habitat due to inundation by the reservoir pool can be compensated by development of a tailwater fishery. Minimum flow releases ranging upward from ten c.f.s. are expected to provide attractive stream fishing conditions below the dam. Access, together with appropriate facilities to insure availability of the tailwater fishery to the public should be included in development of project plans.

Reservoir zoning will be necessary to insure optimum fishing conditions. If the reservoir is no more than 600 acres in area, it would be highly desirable to restrict high speed boating by limiting horsepower of motorboats. If a larger conservation pool is planned, zoning on an area basis, on a time of day basis, or by other means can be used to help attain optimum fishing conditions.

Modification of project plans to include a larger conservation pool would proportionately reduce valuable habitat for terrestrial wildlife. However, that modification would result in a substantially greater reservoir fishery. Also, greater downstream flows would improve several miles of stream fishery. Fishing for smallmouth bass, channel catfish, and other game fish in the tailwaters and other downstream areas would improve significantly as minimum flows increased. Reservoir fishing could be expected to at least double if a conservation pool approaching 1,800 acres became a project feature. In view of the high fishery benefits associated with the larger conservation pool, we conclude that the largest possible pool consistent with other project purposes, up to an elevation of approximately 945', would be preferable from an overall fish and wildlife standpoint.

RECOMMENDATIONS

The following recommendations are provided in recognition of the existing and potential fish and wildlife resource values of the Ames Reservoir area and the probable effects of the project on those resources.

It is recommended that the following language be incorporated in the recommendations of the report of the District Engineer of the Corps of Engineers:

1. That additional detailed studies of fish and wildlife resources be conducted, as necessary, after the project is authorized, in accordance with Section 2 of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq); and that such reasonable modifications be made in the authorized project facilities as may be agreed upon by the Director of the Bureau of Sport Fisheries & Wildlife and the Chief of Engineers, for the conservation, improvement and development of those resources.

2. That prior to establishment of clearing specifications and determination of plans for recreational development, a joint discussion be held between representatives of the Corps of Engineers, the Iowa Conservation Commission, the Bureau of Outdoor Recreation, and this Bureau, to formulate mutually acceptable plans for reservoir clearing, zoning, and provision of public access facilities.

3. That selected project lands and waters below the fee-taking line be made available to the Iowa Conservation Commission under the provisions of the terms of a General Plan, in accordance with Section 3 of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

4. That Federal lands and project waters in the project area be open to public use for hunting and fishing so long as title to the lands and structures remains in the Federal Government, except for sections reserved for safety, efficient operation, or protection of public property.

5. That leases of Federal land in the project area reserve the right of public use of such land for hunting and fishing.

6. That the conservation, improvement, and development of fish and wildlife resources be among the purposes for which the project is to be authorized.

7. That all lands necessary for carrying out the various purposes of the project be acquired in accordance with the provisions of the Joint Policy of the Departments of the Interior and of the Army relative to reservoir project lands of February 16, 1962 and that flowage easements be acquired only on those lands found not to have substantial value for recreation or fish and wildlife purposes.

8. That rough fish populations upstream from the damsite be eliminated prior to dam closure wherever practicable and that project operations allow for continued control of rough fish. It is further recommended that a low-level outlet be incorporated in the design of the dam to help implement this phase of fishery management.

9. That consideration be given to development of subimpoundments to insure that waterfowl and other aquatic wildlife are provided optimum with-the-project living conditions.

10. Reservoir operations be reviewed with the Iowa Conservation Commission and this Bureau to assure maximum fish and wildlife benefits consistent with other needs of the project.

11. The largest possible conservation pool, consistent with other needs of the project, be favored in project planning, in order to realize the maximum overall fish and wildlife values.

We will appreciate receiving your views regarding these recommendations. It is important that we be informed as soon as possible regarding the plan selected for authorization. This will permit us to make an early start on the further studies which will be required, or to revise our report if necessary.

The cooperation and assistance furnished by your staff are appreciated.

Sincerely yours,

W. P. Schaefer

W. P. Schaefer
Acting Regional Director

FEDERAL POWER COMMISSION
REGIONAL OFFICE
610 South Canal Street
Chicago, Illinois 60607

November 27, 1964

Colonel Howard B. Coffman, Jr.
District Engineer
U. S. Army Engineer District, Rock Island
Corps of Engineers
Clock Tower Building
Rock Island, Illinois 61202

Dear Colonel Coffman:

We have made a study of the hydroelectric power potential at the proposed Ames Reservoir at mile 220.6 on Skunk River, Iowa. Our studies were based upon information contained in the "Special Report, Ames Reservoir, Skunk River, Iowa" dated May 1964, and subsequent information contained in your November 16, 1964 letter to this office.

To determine the hydroelectric power potential at the Ames Reservoir site, we assumed that the conservation pool below elevation 949 could be used solely in the interest of power. A power storage drawdown equal to one-third of the head below elevation 949 would provide 23,500 acre-feet of active power storage.

A mass curve analysis of the flows in Skunk River indicates that this storage would provide a regulated flow of about 28 cfs during the critical period of 19 months extending from July 1955 to March 1957. An estimated continuous power output of about 71 kilowatts, when used at a 10 percent plant factor during the critical period, would permit an installed capacity of only 710 kilowatts.

Pursuant to the foregoing, it is our conclusion that the small hydroelectric development physically possible at this site would not be economically feasible.

Sincerely yours,

Kenneth G. Tower
Regional Engineer

EXHIBIT 5

STATE OF IOWA
IOWA NATURAL RESOURCES COUNCIL
STATE HOUSE
DES MOINES 19, IOWA

OTHIE R. McMURRY, DIRECTOR
R. G. BULLARD, WATER COMMISSIONER

March 20, 1963

Colonel Richard L. Hennessy
U. S. Corps of Engineers
Rock Island District
Clock Tower Bldg.
Rock Island, Illinois

Dear Colonel Hennessy:

The subject of preserving the Ames Reservoir Site on the Skunk River in relationship to Interstate Highway # 35 proposed location was discussed by the Iowa Natural Resources Council at their recent meeting on March 14, 1963. The contents of a letter dated March 4th, addressed to you and written by Mr. Clauson of the Iowa State Highway Commission was also discussed.

Unfortunately the Council was unable to come up with any recommended solution to the difficult problem involved. It appears that the State of Iowa is in the position of not having the funds, nor the necessary legal tools at the present time to solve the problem involved. It also appears that neither the Corps of Engineers, nor the Bureau of Public Roads have the necessary tools at their disposal to take care of the problem either.

The Council is quite concerned that the State is faced with possible destruction of one of its few reservoir sites. It is also alarmed to find that there appears to be no tools available for solving the problem involved. In the interest of preserving reservoir sites throughtout the nation and avoiding possible duplicate federal expenditures some Congressional action maybe warranted.

One of the most difficult areas involved is that dealing with the timing of proposed construction of the highway in relation to an authorized restudy by the Corps of Engineers on the flood control aspects. It is unfortunate indeed that the proposal of a restudy of the area presented by Congressman Smith at our meeting in December of last year could not become a reality ahead of land purchases and construction of the highway.

EXHIBIT 6

The Council recommends that all parties involved continue to explore possible solutions to the problem of destruction of potential reservoir sites. One thought that we have discussed briefly would be to attempt to make arrangements for the Highway Commission to purchase sufficient right-of-way and to prepare the base of the road fill in such a manner that the fill itself could be raised the additional height required to accomodate the Interstate Highway above flood pool elevation. This should conserve some public funds and provide for the alternations needed in the highway should the reservoir in this area be constructed at a later date. We have not discussed this matter with the Highway Commission to see whether or not such a proposal would be possible or feasible.

There maybe other alternatives which will come to your attention or to ours, and should either organization have any new ideas or suggestions, we should make an effort to explore any new ideas as soon as possible. We will plan to keep you advised should we have any new ideas or learn of any new development and would appreciate you keeping us advised of any new developments in your organization.

Sincerely yours,

Othie R. McMurry

OTHIE R. MCMURRY
Director

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AMES RESERVOIR - SKUNK RIVER, IOWA

APPENDIX E

PROJECT DEVELOPMENT

U. S. Army Engineer District, Rock Island
Corps of Engineers
Clock Tower Building
Rock Island, Illinois

APPENDIX E

PROJECT DEVELOPMENT

AMES RESERVOIR - SKUNK RIVER, IOWA

1. General. The purpose of this appendix is to support the engineering analysis and to tie into the economic analysis and project formulation. Ames Reservoir was included in a previous report on Skunk River prepared in 1951. The project contemplated in that study included a chute spillway on the right bank with crest elevation at 960.

2. The major changes from the Ames Reservoir study made in 1951 and the current interim study pertain to increased relocations cost resulting from the location of Interstate No. 35 in the reservoir area, change in the spillway location and higher reservoir level. Interstate 35 would traverse about 3 miles of the reservoir area and a major modification of this reach of the Interstate would be required to adopt the Interstate to meet the reservoir operation requirements. Construction of the Interstate is scheduled to start in the spring of 1965. In the 1951 study, a concrete chute-type spillway was planned on the right bank. The presence of rock on the left bank permits the construction of a less costly spillway. The need for reservoir storage for a wide range of uses makes desirable the development of the greatest capacity that the site will make possible. Studies were made for a range in reservoir levels to formulate the best reservoir project.

3. Other sites considered. Only one other dam site was considered feasible for construction of a reservoir with comparable capacity. The dam site for such reservoir was located about one mile downstream from the proposed site. This plan was rejected on the basis of excessive cost, and limited added storage.

4. Other plans considered. Costs were developed for uncontrolled spillway elevations of 945.5, 957.5, 962.0, 964.0, 966.0 and 968.0 m.s.l. Alternate costs for a gated spillway were also considered. All estimates included the incremental increase in cost of initially constructing Interstate 35 to the higher level as compared to the original estimate of Interstate construction with no reservoir involved.

5. Special consideration. The increase in cost was determined for constructing Interstate 35 (exclusive of cross roads) to conform with the proposed reservoir, in lieu of the original low level design. This cost increase is shown on page B-10 of Appendix B. Remedial measures considered for cross roads between sections 6/7 and 30/31 included alternate plans for raising them in place, one plan considered separate crossings at Skunk River and the Interstate Highway, and the second plan considered realigning and raising them with one structure for each road crossing the highway and river. The latter plan was selected and the cost chargeable to the reservoir project was determined as the total cost of the proposed modification less the cost of the proposed modification for the original Interstate Highway design, as derived from the Highway Commission estimate. The total increase in cost for the Interstate and incidental roads chargeable to the reservoir project is shown on page B-10 of Appendix B.

6. Recommended plan. The recommended plan proposes an earth filled dam with crest elevation of 985.0, a gated spillway through the left bluff with a sill crest elevation of 953.0, and a full pool elevation of 968.0. It provides for initial construction of Interstate Highway 35 to an elevation 5 feet above the full pool, carrying two cross roads over the Interstate Highway, and for raising of State Highway 221 also to an elevation 5 feet above full pool. In addition, remedial works are required for one other road to be made submersible and for the sewage treatment plant at Story City, Iowa.

7. Studies made to determine the reservoir size at which benefits are maximized indicated that a reservoir with top of flood control pool at elevation 968 met the maximization criteria. The maximization studies are reviewed in Appendix A. Two arrangements of structures were analyzed with the top of the flood control pool at elevation 968, as outlined below.

a. One arrangement provided for a spillway crest at elevation 968. Routing the standard project flood through a full pool with that spillway crest elevation results in a water surface elevation higher than elevation 980 at Story City. Elevation 980 is considered to be the critical elevation at Story City above which severe damage would be experienced. Therefore, local protection works are required at Story City with a spillway crest elevation at 968.

b. The second arrangement provided for a gated spillway with gate sill at elevation 953. Routing the standard project flood through a full pool with a gated spillway results in a water surface elevation of 975 at Story City. At that elevation, the only remedial work required at Story City would be a small amount of work to assure continued operation of the sewage treatment plant at high reservoir levels.

8. The cost estimate for the arrangement including a spillway crest at elevation 968 and local protection works at Story City is slightly lower than the second arrangement with gated spillway and no local protection works. The arrangement with the gated spillway was selected for this report to avoid the problems involved in local protection works and to produce a more conservative (higher) cost estimate. In the advance engineering and design stage after authorization of the project, more detailed studies will be made on which to base a selection of type of spillway and to determine whether or not local protection works should be provided for Story City.

9. Some features of the dam and spillway are somewhat preliminary in nature and will require revision during detailed design studies when more detailed foundation data are available. However, where questionable factors exist, contingencies have been increased to provide a reasonably sound cost estimate.

10. The costs of the proposed gated spillway were derived from the costs of similar structures on the Mississippi River nine-foot channel system with an updating of cost from 1937 to 1964.

INTERIM REVIEW OF REPORTS
FOR FLOOD CONTROL AND OTHER PURPOSES
ON THE SKUNK RIVER, IOWA - AMES RESERVOIR

APPENDIX F

DIGEST OF PUBLIC HEARING

U. S. Army Engineer District, Rock Island
Corps of Engineers
Clock Tower Building
Rock Island, Illinois

INTERIM REVIEW OF REPORTS
FOR FLOOD CONTROL AND OTHER PURPOSES
ON THE SKUNK RIVER, IOWA - AMES RESERVOIR

APPENDIX F
DIGEST OF PUBLIC HEARING

A public hearing in regard to flood control and major drainage problems in the Skunk River Basin was held by the District Engineer at Newton, Iowa, on 27 February 1964. The notice of the public hearing, accompanied by location maps and descriptions of the Ames and Gilbert Reservoirs, was sent to all organizations and individuals believed to have an interest in the problems.

Registered attendance at the public hearing was 443 persons. After introductory and explanatory remarks by the District Engineer, those in attendance were called upon for their statements. In general, those persons downstream from the reservoirs favored the projects, while those upstream were opposed.

The Honorable Neal Smith, Fifth Congressional District of Iowa, was the first speaker. Congressman Smith spoke of the recent increase in population and expansion of industry in Iowa, and of the growth which could be expected in the future. He emphasized that a greatly increased water supply must be provided for various future uses, including augmentation of low flows for the protection of health and for the benefit of fish and wildlife. He expressed the opinion that study would indicate that both the Ames and Gilbert Reservoirs are needed, not only for flood control, but also for water storage.

Mr. R. H. Hogrefe, District Engineer, Bureau of Public Roads, spoke of the pending construction of Interstate Highway No. 35 through the Ames Reservoir area. He said that development of present plans for the highway had required a considerable length of time, and mentioned the matter of financing the increased cost of a high-level crossing of the reservoir. He stated that in order to meet the schedule for completion of the National System of Interstate and Defense Highways, as established by Congress, delay in construction of Interstate 35 was not feasible.

Mr. Othie R. McMurry, Director of the Iowa Natural Resources Council, spoke of past efforts of organized drainage districts and individual landowners in the Skunk River Basin to control floods by privately built levees and drainage ditches, but that floods were still a major problem on

thousands of acres of excellent farm land in the basin. He emphasized the Natural Resources Council's continuing deep interest in the problem.

Dr. E. Robert Baumann, Professor of Civil Engineering, representing James H. Hilton, President of the Iowa State University at Ames, read a statement from the latter, expressing the University's interest in flood control and water resources development, not only in its administration of University lands located in the flood plain, but also because of its educational interest in water and related land resources.

Mr. Harry M. Harrison, representing the Iowa Conservation Commission, expressed a neutral position on the part of the Commission until further study had been made to determine the effect of the project on fish and wildlife resources.

The District Engineer read a statement received from the Chief Engineer of the Iowa State Highway Commission, stating that construction of Interstate Highway 35 across the reservoir area was proposed for calendar year 1965, to be ready for public use by the fall of 1966, and that it is mandatory that an early decision be reached as to whether or not alterations in the proposed highway construction are desirable, and if so, how they would be financed.

Mr. W. T. Doran, Attorney, Boone, Iowa, was the next speaker. Mr. Doran said he represented organizations and individuals in Story, Boone, and Hamilton Counties, totaling from 75,000 to 100,000 persons. He said that thousands of acres of fertile farm land would be severely damaged, that the reservoirs would soon fill with sediment, and that farm tiling on adjoining lands would cease to function. Mr. Doran believed that the providing of recreational lakes should not be a Federal responsibility, and said that several recreational lakes were being built in the area at local expense. He further spoke about the public roads which would be destroyed or abandoned and about the loss of scenic values in the Ames Reservoir area. Mr. Doran said that Skunk River and Squaw Creek often go dry and that it would be impossible to maintain lakes behind the dams in those times. He also indicated that he had made an investigation of the corn production index along the Skunk River downstream from the Ames Reservoir site which revealed that production percentages were high and cited such percentages for a number of individual farmers in that area.

Mr. B. E. Newell, County Supervisor, Polk County, said that the farmers along the Skunk River in Polk County had spent a large amount of money over the years in constructing levees, drainage ditches, and farm ponds, and that many of them were terracing and contouring on their farms, but that they still needed outside assistance to solve the flood problem.

Mr. Roy O. Ellis, Superintendent of the Municipal Water Department at Oskaloosa, said that his city was the only sizeable community in the basin which depended upon the Skunk River for its water supply. Mr. Ellis said that his position toward the reservoirs would be governed entirely by their effect on the Oskaloosa water supply.

Mr. Homer E. Bradshaw, Attorney, Des Moines, represented Drainage District No. 25 in Polk County, an area of 15,300 acres along the Skunk River. He knew of no opposition to the proposed reservoirs in that area, and said that the people were eager for the Corps to continue the study to arrive at a solution to the flood problem.

Mr. D. L. Maloney, speaking for the same drainage district, also favored the two reservoirs. He said that it was true that the basin in Polk County had high production indexes in good years, but not in flood years.

Mr. Ralph C. Mathis, a farmer in Polk County, spoke briefly of the floods on Skunk River in 1944 and 1947. He said that the income in that area for those years was very low.

Mr. W. P. Gannon, a farmer and formerly active in the Skunk River and Tributaries Association, quoted figures of acres flooded in the 1944 flood and of flood damages in the 1944 and 1947 floods. In 1944, he said there were 114,000 acres flooded in Story, Polk, and Jasper Counties, with a dollar damage of $1,842,000 in the reach from Highway No. 30 to the mouth of Indian Creek in Jasper County, and that in 1947 the dollar damage in the same reach was $1,522,000.

Mr. Bradshaw asked that persons in attendance from Drainage District No. 25 rise. An estimated 100 persons rose.

Mr. James T. Brown, Secretary-Treasurer of the Upper Skunk River Conservation Commission, Ames, spoke in opposition to the Ames and Gilbert Reservoirs. Mr. Brown said that his organization thought that the claimed flood damages far exceeded the actual damages. He said that crop indexes for Polk and Story Counties indicated a higher index in the bottom lands than in the county as a whole, and that he had found that there was little or no flood damage in the city of Ames. He called for a more realistic estimate of what the two dams would cost in real property taken, loss of income, taxes, and roads, and damage to drainage systems. He further expressed the opinion that the reservoirs would have little attraction as recreational lakes.

Mr. Don F. Hadwiger, Associate Professor of Government, Iowa State University, spoke in favor of the reservoirs from the standpoint of need for additional recreational facilities in the area.

Mr. Harold L. Jones, Hayesville, Iowa, said that he represented 14,500 flooded acres in the Skunk River flood plain in Keokuk County. He said that in the 1940's his area had floods every year, and that in the 10-year period the flood damage was $4,843,000. He said that his area was at the end of a river straightening project, and he favored the dams to hold back flood flows.

Mr. Randall Matson, President of the Story County Farm Bureau, opposed the reservoir projects because he thought they would disrupt community life, reduce tax revenue, and cause damage to drainage systems. He believed that soil conservation practices could accomplish the objectives more economically and efficiently. Mr. Martin Mitchell, Director of the Boone County Farm Bureau, also opposed the projects, generally for the same reasons.

Mr. A. H. Lekwa, Story City, also advocated soil conservation practices instead of reservoirs. He spoke of the scenic attractions of the Skunk River Valley downstream from Story City which would be destroyed if the Ames Reservoir were built.

Request was made from the floor that persons opposed to the dams stand. An estimated 300 persons rose.

Mr. C. L. Schwenk, representing the Gilbert Community School District, thought that the School District would be adversely affected by the projects and therefore was opposed to their construction.

Mr. Carl P. Lechner, Lechner Engineering Co., Ames, observed that most of the expressions at the hearing were based upon the effect of the projects on individual interests. He thought that, instead, a broad overall outlook must be taken as to the effect of the projects on the Skunk River Basin, based on the needs of the future. He favored the reservoirs, not only for flood control, but also as a means of water storage and replenishment of the ground water supply. He suggested that other reservoir sites be investigated in the basin for these purposes, particularly on Keigley Branch

Mr. Kermit Miskell, Story City, a farmer, opposed the projects because he thought they would adversely affect the tile drainage systems, would cause a tax loss, and would disrupt community life.

A total of 106 written statements were received from various interests in regard to the proposed reservoirs, generally advancing the arguments, pro or con, as expressed verbally at the public hearing.

INTERIM REVIEW OF REPORTS
FOR FLOOD CONTROL AND OTHER PURPOSES
ON THE SKUNK RIVER, IOWA - AMES RESERVOIR

ATTACHMENT I

Information called for by Senate Resolution 148,
Eighty-fifth Congress, 1st Session,
adopted 28 January 1958

U. S. Army Engineer District, Rock Island
Corps of Engineers
Clock Tower Building
Rock Island, Illinois

ATTACHMENT I

INTERIM REVIEW OF REPORTS FOR FLOOD CONTROL AND OTHER PURPOSES ON THE SKUNK RIVER, IOWA - AMES RESERVOIR

Information called for by Senate Resolution 148,
Eighty-fifth Congress, 1st Session,
adopted 28 January 1958

1. RECOMMENDED PROJECT

This interim report is confined to the multiple-purpose aspects of the Ames Reservoir and the relationship of the reservoir to the projected U. S. Interstate Highway No. I-35. The highway, not yet constructed, is planned such that a segment will traverse the reservoir. The report considers, as a feature of reservoir costs, the additional cost required to raise the road to conform with the reservoir plans.

2. The dam site for the reservoir is at mile 220.6, about 5 miles upstream from the city of Ames. The multiple aspects of the reservoir would provide benefits for flood control, water quality control, water supply, recreation, and fish and wildlife. The project would consist of an earth fill dam with gated spillway, a reservoir capacity of 94,000 acre-feet, of which 60,600 acre-feet would be for flood control, 25,000 acre-feet for water quality control and water supply, and 8,400 acre-feet for sedimentation.

3. PROJECT COST

The estimated cost of the project, based on prices prevailing in November 1964, is as follows:

Federal cost	$10,130,000

4. ANNUAL COSTS AND BENEFITS

The average annual costs are based on an economic life of 100 years. Interest and amortization were computed on the basis of 3-1/8 percent. Amortization of the costs over a shorter period, such as a 50-year life, would not result in a change in annual charges sufficient to alter the feasibility of the project.

Annual charges	Annual benefits	Benefit-cost ratio
$401,145	$726,300	1.7

5. ALTERNATIVE PROJECTS

As indicated in paragraph 1, the study was confined to the multiple-purpose aspects of Ames Reservoir and the relationship of the reservoir to the projected Interstate 35. The reservoir is economically justified and would be the key element in the comprehensive over-all basin plan for water resource development to be formulated in a later report. Interstate 35, tentatively scheduled for construction in 1965, has a strong impact on the cost of Ames Reservoir. If the Interstate is constructed originally at a level high enough to meet reservoir operation, in lieu of being raised after having been constructed as currently planned, a savings of about $1,682,000 would be realized.

6. ALLOCATION OF COSTS

Cost allocations between project purposes were applied to the Ames Reservoir for flood control, water quality control, water supply, recreation, and fish and wildlife. The water supply cost allocation is shown in the following tabulation because a segment of storage has a dual assignment of water quality control and water supply. However, costs are assigned only to water quality control at this time. Water supply storage would not be required, initially, until the year 2020. Since the need for water supply storage is so far in the future, no provisions have been made for local participation in project costs at this time. If a need for water supply arises in the future, the local requesting agent would contribute toward the project cost in accordance with procedures then in use. The costs for the plan were allocated by the "Separable Costs - Remaining Benefits Method." The following tabulation indicates the allocation of costs among purposes, using a 100-year economic life.

Allocation of costs	Allocation
Flood control	$5,430,000
Water quality control	3,262,000
Water supply	243,000
Fish and Wildlife	344,000
Recreation	851,000
Total	$10,130,000

(1) See text of paragraph 6.

7. EXTENT OF INTEREST IN PROJECT

The U. S. Public Health, the Fish and Wildlife Service, the Bureau of Outdoor Recreation, groups and individuals, including the Iowa State University at Ames, expressed interest in and desire for the reservoir. Objection to the project derived from groups and individuals primarily located within or upstream from the reservoir.

8. EFFECT OF PROJECT ON STATE AND LOCAL GOVERNMENTS

No adverse effects on State and local governments are anticipated from the recommended project.