February

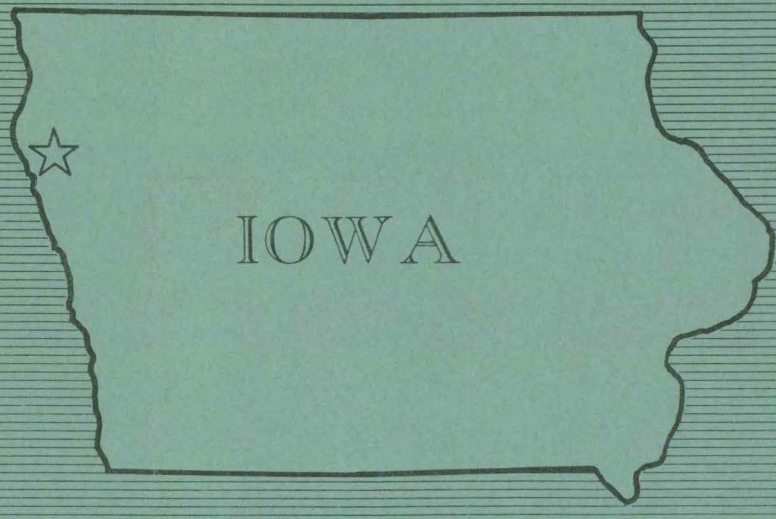
# WORK PLAN

## FOR WATERSHED PROTECTION, FLOOD PREVENTION, AND RECREATION DEVELOPMENT



# BACON CREEK WATERSHED

Woodbury and Plymouth Counties
Iowa






OUR SOIL ★ OUR STRENGTH

USDA-SCS-LINCOLN, NEBR. 1969

# WATERSHED WORK PLAN

## BACON CREEK WATERSHED
Woodbury and Plymouth Counties, Iowa

(14,895 ac. or 23.3 sq. mi.)

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, 68 Stat. 666) as amended.

Prepared by: Woodbury County Soil Conservation District
Plymouth County Soil Conservation District
Woodbury County Board of Supervisors
Plymouth County Board of Supervisors
City of Sioux City

With Assistance by

U. S. Department of Agriculture, Soil Conservation Service
U. S. Department of Agriculture, Forest Service

November 1970

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

# WATERSHED WORK PLAN AGREEMENT

between the

WOODBURY COUNTY SOIL CONSERVATION DISTRICT
PLYMOUTH COUNTY SOIL CONSERVATION DISTRICT
WOODBURY COUNTY BOARD OF SUPERVISORS
PLYMOUTH COUNTY BOARD OF SUPERVISORS
CITY OF SIOUX CITY
in the State of Iowa
(hereinafter referred to as the Sponsoring Local Organizations)

and the

SOIL CONSERVATION SERVICE
United States Department of Agriculture
(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organizations for assistance in preparing a plan for works of improvement for the Bacon Creek Watershed, State of Iowa, under the authority of the Watershed Protection and Flood Prevention Act (P.L. 566, 83d Congress, 68 Stat. 666) as amended: and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organizations and the Service a mutually satisfactory plan for works of improvement for the Bacon Creek Watershed, State of Iowa, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organizations and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about six years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. Except as hereinafter provided, the Sponsoring Local Organizations will acquire without cost to the Federal Government such land rights as will be needed in connection with the works of improvement. (Estimated cost $105,870). The percentages of this cost to be borne by the Sponsoring Local Organizations and the Service are as follows:

| Works of Improvement | Sponsoring Local Organizations (Percent) | Service (Percent) | Estimated Land Rights Cost (Dollars) |
|---|---|---|---|
| Multi-Purpose Str. A-2-4 & Public Recreational Development | | | |
| Payment to landowners for about 242 acres | 50 | 50 | 42,400 |
| Legal fees, survey costs, flowage easements, and other | 100 | 0 | 850 |
| All other structural measures | 100 | 0 | 61,870 |
| Wildlife Mitigation measures | 100 | 0 | 750 |

The Sponsoring Local Organizations agree that all land acquired or improved with P. L. 566 financial or credit assistance will not be sold or otherwise disposed of for the evaluated life of the project except to a public agency which will continue to maintain and operate the development in accordance with the Operation and Maintenance Agreement.

2. The Sponsoring Local Organizations will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of works of improvement.

3. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organizations and by the Service are as follows:

| Works of Improvement | Sponsoring Local Organizations (Percent) | Service (Percent) | Estimated Construction Cost (Dollars) |
|---|---|---|---|
| 1 Multiple Purpose Structure A-2-4 | 10 | 90 | 156,340 |
| 1 Drawdown Pipe & Gate | 50 | 50 | 5,160 |
| Basic Recreation Facilities | 50 | 50 | 217,680 |
| 1 Gr. Stab. & Road Structure H-2 | 50 | 50 | 26,880 1/ |
| 35 Other Structural Measures | 0 | 100 | 1,040,360 |
| Wildlife Mitigation Measures | 0 | 100 | 1,800 |

1/ Non-Project costs for road purpose are included in this value.

4. The distribution of estimated costs for engineering services to be borne by the Sponsoring Local Organizations and the Service is as follows:

For structure H-2 the distribution will be 50% Service and 50% Sponsoring Local Organizations. This will be accomplished by assigning engineering services to be performed by the City of Sioux City equal in value to the engineering services to be performed by the Service. This specific assignment of responsibilities is set forth in detail in the work plan.

For all other structural measures, the percentages of the costs for engineering services to be borne by the Sponsoring Local Organizations and the Service are as follows:

| Works of Improvement | Sponsoring Local Organizations (Percent) | Service (Percent) | Estimated Engineering Cost (Dollars) |
|---|---|---|---|
| 1 Multiple Purpose Structure A-2-4 | 0 | 100 | 32,300 |
| Basic Recreation Facilities | 50 | 50 | 43,540 |
| 35 Other Structural Measures | 0 | 100 | 209,080 |

5. The Sponsoring Local Organizations and the Service will each bear the costs of Project Administration which it incurs, estimated to be $18,620 and $210,510 respectively.

6. The Sponsoring Local Organizations will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

7. The Sponsoring Local Organizations will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

8. The Sponsoring Local Organizations will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

9. The Sponsoring Local Organizations will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

10. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

11. This agreement is not a fund obligating document. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

    A separate agreement will be entered into between the Service and the Sponsoring Local Organizations before either party initiates work involving funds of the other party. Such agreements will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

12. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.

13. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom, but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

14. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. Sec. 15.1-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal financial assistance.

WOODBURY COUNTY SOIL CONSERVATION DISTRICT
Local Organization

By_____

Title_____

Address_____
Zip Code

Date_____

The signing of this agreement was authorized by a resolution of the governing body of the Woodbury County Soil Conservation District adopted at a meeting held on _____ 19___.

_____
(Secretary, Local Organization)

Address_____
Zip Code

Date_____

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PLYMOUTH COUNTY SOIL CONSERVATION DISTRICT
Local Organization

By_____

Title_____

Address_____
Zip Code

Date_____

The signing of this agreement was authorized by a resolution of the governing body of the Plymouth County Soil Conservation District adopted at a meeting held on _____ 19___.

_____
(Secretary, Local Organization)

Address_____
Zip Code

Date_____

WOODBURY COUNTY BOARD OF SUPERVISORS
Local Organization

By_____

Title_____

Address_____
Zip Code

Date_____

The signing of this agreement was authorized by a resolution of the Woodbury County Board of Supervisors, governing body of Woodbury County, adopted at a meeting held on _____ 19___.

_____
County Auditor

Address_____
Zip Code

Date_____

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PLYMOUTH COUNTY BOARD OF SUPERVISORS
Local Organization

By_____

Title_____

Address_____
Zip Code

Date_____

The signing of this agreement was authorized by a resolution of the Plymouth County Board of Supervisors, governing body of Plymouth County, adopted at a meeting held on _____ 19___.

_____
County Auditor

Address_____
Zip Code

Date_____

CITY OF SIOUX CITY

By_____

Title_____

Address_____
Zip Code

Date_____

The signing of this agreement was authorized by a resolution of the City Council, governing body of the City of Sioux Sioux, adopted at a meeting held on _____ 19___.

_____
City Clerk

Address_____
Zip Code

Date_____

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SOIL CONSERVATION SERVICE
United States Department of Agriculture

By_____
Administrator

Date_____

WATERSHED WORK PLAN

BACON CREEK WATERSHED
Woodbury and Plymouth Counties, Iowa

November 1970

## SUMMARY OF PLAN

### Participating Organizations

The Work Plan for the Bacon Creek Watershed, Woodbury and Plymouth Counties, Iowa was prepared by the Woodbury and Plymouth County Soil Conservation Districts, hereinafter referred to as the Districts; the Woodbury and Plymouth County Boards of Supervisors, hereinafter referred to as the Counties; and the City of Sioux City, hereinafter referred to as the City, as joint local sponsoring organizations. Technical assistance was provided by the United States Department of Agriculture, Soil Conservation Service, hereinafter referred to as the Service. The U. S. Forest Service, cooperating with the Iowa Conservation Commission, Forestry Section, developed the land forest treatment phase of the plan.

### Location and Size

The Bacon Creek Watershed is located in Woodbury and Plymouth Counties in northwestern Iowa. The watershed consists of several tributaries which outlet into both the old and the improved channel of the Floyd River. The Floyd in turn empties into the Missouri River in Sioux City. There are 14,895 acres or 23.3 square miles in the drainage area. A portion of Sioux City lies within the watershed.

### Watershed Problems

The major watershed problems are gully erosion damage to urban and agricultural lands, floodwater and sediment damages to homes, streets, road ditches, outlet channels, and business establishments in or near the city limits of Sioux City. Land is being destroyed or depreciated to a lesser use due to gully erosion. The land being damaged consists of valuable farm units and small urban acreages.

Sioux City and the State Highway Department have a high cost of annual maintenance and clean-up of streets, culverts, road ditches, etc. According to the General Plan for Sioux City, there is a need for expansion in this part of the City for new housing. An outer belt drive is planned as a future development and is located near the center of the watershed.

Local people have expressed an interest in developing a recreation area as a part of the project. A place to fish, swim and picnic are of most concern at the present time.

The average annual value of gully erosion, floodwater, sediment and indirect damages are $138,030 (Table 5).

Proposed Works of Improvement

The project for the protection and development of the watershed will be installed during a six-year project installation period at a total cost of $2,147,690. The P.L. 566 share of the cost is $1,807,230 and the other or local share is $340,460 (Table 1).

Land treatment measures for erosion control will be installed on nearly all of the cropland areas where sheet erosion is a problem. The land treatment measures to be installed are level and basin type terraces, grassed waterways, contour farming, and conservation cropping systems. The installation cost of these measures is estimated to be $90,300 of which $2,030 is for accelerated technical assistance to be provided from P.L. 566 funds. The remaining $88,270 will be borne by the landowners, State funds, and Federal funds provided under authorities other than P.L. 566.

The land treatment measures will be maintained by the landowners and/or operators of the farms on which these measures are to be installed in accordance with cooperative agreements entered into with the District.

Thirty-one grade stabilization structures, five floodwater retarding and sediment control structures, and one multiple purpose structure, with a drawdown pipe and gate and basic recreational facilities will be installed during a six-year project installation period. The estimated installation cost of the structural measures and recreational facilities is $2,057,390. Of this amount, P.L.566 funds will bear $1,805,200 and other or local funds will bear $252,190 (Table 1).

The structural measures located within the city limits of Sioux City will be operated and maintained by the City. Other structures will be operated and maintained by the County and District in which they are located.

The estimated annual operation, maintenance and replacement cost of the structural measures is $4,920. The estimated operation, maintenance and replacement cost of the basic recreational facilities is $15,940. This gives a total operation, maintenance and replacement cost of $20,860 (Table 4).

## Project Benefits

The benefits of the project have important effects on the inhabitants and lands in the watershed. Benefits from gully erosion will accrue to 92 farms and to many small urban acreages in the watershed. Floodwater and sediment reduction benefits will be realized by Sioux City, State Highway Department, and homes and business establishments located within the watershed. People living within the watershed and surrounding area will derive benefits from the use of the planned public recreational facilities.

The average annual benefits accruing to the project from both land treatment and structural measures are $234,470. These consist of $36,110 gully erosion damage reduction benefits to agricultural land; $63,020 gully erosion damage reduction benefits to urban land; $3,530 to urban floodwater damage reduction benefits; sediment damage reduction benefits of $18,270; indirect benefits of $10,440; roads $1,120; bridges $1,230; fences $330; farm crossings $360; utility pipelines $770; recreation benefits of $87,620; and secondary benefits of $11,670.

The average annual benefits of the project are $234,030; the average annual costs of the structural measures and public recreational development are $126,960; this gives a benefit-cost ratio of 1.8 to 1.0 (Table 6).

The sediment storage pools in 27 of the structures will provide water storage and recreation in those structures where the water yield is large enough to maintain an adequate pool area and depth. Many of these pools, of 2 to 15 acres in size, will be stocked with fish by the landowners. Wildlife plantings for food and cover will be made by landowners at many of these sites. The pools will provide recreation for many families and their friends for fishing, picnicking, boating, swimming, waterfowl shooting, etc. Monetary values of these benefits were not estimated.

## General

There are 110 farms located entirely or partially within the watershed. Owners of 70 farms are cooperating with the District in installing land treatment measures. Conservation plans have been developed on 38 farms.

There are also many small urban acreages within the watershed. They may have a few livestock but are dependent upon off-farm employment for their livelihood.

Local landowners and operators have installed land treatment measures valued at $125,050 (Table 1A).

## DESCRIPTION OF THE WATERSHED

### Physical Data

Drainage Area: The watershed is located in the northwestern part of Iowa; a portion of Sioux City lies within the boundaries. It includes several tributaries which flow into both the old and improved channel of the Floyd River. The Floyd in turn empties into the Missouri River in Sioux City. The drainage area is 14,895 acres or 23.3 square miles of which 1,335 acres are in Plymouth County and 13,560 acres in Woodbury County. The watershed is approximately seven miles long and four miles wide at its broadest point.

Soils: The soils in the watershed are derived from Wisconsin loessial deposits and are in the Monona-Ida-Hamburg soil association area. The major upland soils are Ida and Monona. Napier-McPaul silt loam soils occupy the upland drainageways and valleys, with Kennebec and McPaul in the bottomland of the Bacon Creek floodplain.

The Ida soils, the most predominant in the area, are light colored and calcareous at or near the surface. The top 7 inches contain about 4 percent sand, 76 percent silt, and 19 percent clay; 7 inches to 40 inches contain about 5 percent very fine sand, 81 percent silt, and 14 percent clay. Ida soils are permeable, well to excessively drained, and are low in organic matter and available phosphate. Erosion control, maintenance of fertility, and moisture conservation are the principal management problems.

The Monona soils are dark-colored. The surface 24 inches contain about 4 percent sand, 74 percent silt and 22 percent clay. This texture continues to about 92 inches when the silt increases to 80 percent and clay decreases to 16 percent. These soils are well-drained and when well managed are very productive. The principal management problems are maintenance of fertility and the control of both sheet and gully erosion.

The drainageway soils (Napier-McPaul) in the upland areas and valleys are similar to, although somewhat heavier textured than, the adjacent soils. The average texture to a depth of 73 inches contain 3 percent sand, 73 percent silt and 24 percent clay. These soils are subject to severe gully erosion.

The bottomland soils along Bacon Creek are light colored on the surface, with an average textural range in the upper 18 to 40 inches of about 9 percent sand, 65 percent silt, and 26 percent clay. They are moderately permeable and well to imperfectly drained. The main bottomland soils are Kennebec and McPaul.

These deep loess soils have excellent workability; dryness and wetness affect their ease of farming less than many of the heavy till soils. The soils respond well to continued intensive cultivation and produce abundant crops with minimum quantities of lime and with ample fertilizer. The water holding capacity for crops is quite high. No stones are present to interfere with tillage; drainage (tile drains) is required only in the minor tributary watercourses.

Topography: Narrow ridgetops with steep sidehill slopes and narrow valleys typify the topography of the area. The floodplain area, next to the Floyd River channel along the west edge of the watershed boundary, is protected from flooding by the installation of channel improvement and levees constructed in 1964 by the Corps of Engineers.

Climate: The climate of the watershed is of the extreme mid-continental type. The spring season may fluctuate from wet to fairly dry. Hot winds and periods of prolonged high temperatures are characteristic of the summer season. Precipitation in the area averages about 26 inches annually. The average frost-free growing season is about 150 days. Extreme temperatures range from -35 degrees to a +111 degrees.

## Economic Data

The major farm enterprise in the watershed is livestock farming with the production of cattle and hogs. According to the 1964 U. S. Census of Agriculture 53 percent of the farms in Woodbury County are livestock farms and are estimated to be representative of the watershed. Other types of farming are divided between cash grain and dairy farms. The principal crops are corn, soybeans, oats, hay and pasture.

One-hundred and ten farms are located entirely or partially within the watershed. There are also a large number of small acreages. Approximately 48 percent of the farms are owner-operated. The average size of farm is 236 acres. The average value of land and buildings per farm is $52,050 or $220 per acre for the county.

The value of land within the watershed is higher than the county average. This is due to a part of the area being within the city limits. Land is selling for as high as $1,000 per acre within the watershed. It is expected there will be a slight decrease in population for Plymouth and Woodbury Counties and the population of Sioux City is estimated to be 118,000 by 1980.

Sioux City serves as the marketing and distribution center for the area. It is a noted livestock marketing and packing

plant center and has many other industries. This provides opportunity for off-farm employment. According to the 1964 U. S. Census of Agriculture, 36 percent of the farms in Woodbury County had off-farm employment. Of these, 21 percent had 100 or more days of off-farm employment. Many of the inhabitants of the watershed live on small suburban acreages and work in the City.

The following table indicates trends in size of farms.

| | Woodbury County | | | | Watershed | |
|---|---|---|---|---|---|---|
| Farm Size | 1959 | | 1964 | | 1964 | |
| Acres | No. | % | No. | % | No. 1/ | % |
| Under 10 | 98 | 4 | 68 | 3 | 13 | 12 |
| 10-49 | 243 | 10 | 152 | 7 | 16 | 15 |
| 50-99 | 205 | 9 | 201 | 9 | 39 | 35 |
| 100-219 | 888 | 37 | 667 | 32 | 26 | 24 |
| 220-499 | 860 | 36 | 876 | 42 | 15 | 14 |
| 500-999 | 104 | 4 | 138 | 7 | 1 | - |
| 1000+ | 9 | - | 15 | - | - | - |
| TOTAL | 2407 | 100 | 2117 | 100 | 110 | 100 |

1/ There are also many small acreages in the watershed.

Transportation in the watershed is adequate. U. S. Highway 20 is located along the lower portion of the watershed and U. S. Highway 75 is located along the western edge. The railroad of Burlington Northern, Inc. is located adjacent to Highway 75. The City of Sioux City is proposing an outer belt drive and this would further enhance the watershed area for urban development. This outer drive proposed to be located adjacent to the recreation development area will provide easy access to the area.

The Woodbury County Soil Conservation District was organized January 7, 1942, and the Plymouth County Soil Conservation District on July 22, 1946. To date, seventy farms are district cooperators and thirty-eight have basic plans. There are many units in the watershed that consist of only a few acres and residents depend upon off-farm employment for their livelihood. Landowners and operators within the watershed have applied land treatment measures valued at $125,050 (Table 1A).

Present forest stands, which occupy 980 acres of the watershed, are mixed hardwood and elm-ash-cottonwood. About 80 percent of the stands are of sawtimber size and 20 percent are of pole size. The local sawtimber market is fair. The forest land is all in private ownership.

Adequate forest fire protection is provided by local fire departments in cooperation with the Iowa State Conservation Commission, Forestry Section and the U. S. Forest Service through the Clarke-McNary Cooperative Fire Control Program.

Other current Federal-State Forestry Programs include Cooperative Forest Management, Cooperative Forestation, and Cooperative Insect and Disease Control.

Land Treatment Data: The following table lists the expected future land use in the watershed:

| | Without Project | | With Project | |
|---|---|---|---|---|
| Land Use | % | Acres | % | Acres |
| Cropland | 43.5 | 6475 | 42.8 | 6360 |
| Pasture | 27.2 | 4049 | 25.0 | 3737 |
| Forest Land | 6.6 | 980 | 6.3 | 941 |
| Wildlife Recreation Land | - | - | 2.7 | 406 |
| Other 1/ | 2.0 | 301 | 2.0 | 301 |
| Urban | 20.7 | 3090 | 21.2 | 3150 |
| Total | 100% | 14,895 | 100% | 14,895 |

1/ Includes farmsteads, roads, etc.

A principal rotation being used in the upland area is two years row crop, one year of oats, and one year of meadow. The bottomlands are farmed intensively to row crops of corn and soybeans. Some of the pastures have been renovated and have adequate cover. However, unimproved pastures are overgrazed at times, and have only fair cover.

Fish and Wildlife Resource Data

The northern half of the watershed is intensively farmed and supports little wildlife food or cover. The more rolling terrain of the southern section provides good wildlife habitat. Deer, rabbits, squirrels, pheasants, and quail are present in fairly large numbers. The watershed lacks a permanent stream fishery.

## WATERSHED PROBLEMS

Croplands in the watershed area are rolling to steep. A major portion of the cropland is in row crop of corn and soybeans. Sheet erosion is prevalent where corrective conservation treatments have not been applied. Needed land treatment measures such as terraces, contour farming, and waterways are progressively being applied in the watershed.

Some areas will need to receive added emphasis in order to provide for the necessary percentage of land properly treated above the structural measures to be installed. It is expected that through educational meetings and demonstrations of the effectiveness of conservation measures, that the necessary land treatment measures will be applied during the six-year installation period.

Erosion Damage

Sheet Erosion: Excessive sheet erosion has occurred on many of the sloping cropland areas of the watershed. Land treatment measures installed in recent years have corrected this problem on a major portion of the cropland area. Some steep cropland areas were converted to permanent pasture. Continuation of severe sheet erosion on the untreated erosive areas would cause a gradual decline in the productivity of those areas by further removal of the fertile topsoil.

The amount of soil lost from sheet erosion under present conditions and with the planned land treatment measures installed, was studied and computed for use in formulating an adequate land treatment program for watershed protection. This erosion data was also used in estimating sediment storage requirements for the detention type structures. The present rate of soil loss from sheet erosion, averaged over all of the upland area, is estimated to be 4.4 tons per acre per year. This erosion ranges from a high of 47 tons per acre per year to a low of one ton. About 11,369 acres of land in the watershed are considered adequately treated; the treatment of 2,881 acres is considered inadequate, that is, soil loss exceeds the five tons per acre per year tolerable limits.

Gully Erosion: Gully erosion damage to land is a major problem in the watershed. It occurs as land voiding and associated depreciation of the productive capacity of other nearby areas in a farm unit, especially those areas adjacent to the voided gully area. The laterals which advance from the main gullies establish a pattern which makes it necessary to abandon field cropping on most of the areas in between, permitting the use of the land only as pasture or idle areas. These areas cannot be profitable farmed because of their relatively small size, the cost of maintaining crossings, or the extra travel involved. The size of gullies is a major reason for not developing this area for housing. The gullies range in width from 40 to 100 feet and in depth from 10 to 35 feet. If erosion is permitted to continue at its present rate, much valuable cropland and urban land will be destroyed and the general economy of the local community will be adversely affected. It is estimated that about 4,340 acres of land will be damaged during the 100-year evaluation period if the project or similar measures are not installed.

Gully erosion damage to farm fences also occurs. The sloughing and caving of the gully banks cause cross and parallel fences to be frequently damaged. Gully erosion also damages farm field crossings by undermining the supports and approaches.

Gully erosion damage occurs in areas of the watershed where structural measures are not planned; however, the installation of structural measures was found to be not economically feasible in these areas. Only damages affected by structural measures are included in the work plan. The estimated average annual damages from gully erosion are as follows: Urban land $63,020; agricultural land $36,110; farm crossings $360; fences $330; roads $1,120; utility pipelines $770; bridges $1,230; for a total of $102,940 (Table 5).

Sediment Damage

The cost of removing deposits of sediment from the road ditches by the State Highway Department and the City on city streets and the cleanup of other debris will be greatly reduced by the proposed measures in Laterals A, B, C, and D of this project. The estimated average annual sediment damages are $20,300 (Table 5).

Floodwater Damage

Floodwater damages have been evaluated from information secured by interviews. Floodwater damages have occurred along the main channel of Bacon Creek or the "A" tributary, and in the area of the "D" tributary.

A major flood occurred in the "A" tributary in the Greenville area of the City in July 1955. Many homes and business places suffered damages during this storm. It was estimated that a storm of this size has a frequency of occurring once in about 25 years. Estimated damages from all floods in this tributary are $3,030 annually.

Floodwater damages occurring on the "D" tributary are to a furniture store, roads, channels, etc. The estimated damage is $500 annually.

The total urban floodwater damage is $3,530 (Table 5). The entire floodplain is within the City limits.

Indirect Damages

Field studies indicated that indirect damages occur in the watershed and consist of increased cost of normal field operation, rerouting of traffic, farm equipment breakage, interruption in pasturage resulting from fence damage, breaking out of livestock, etc. An estimated 10 percent of the direct damages were used as a monetary value for indirect damages. The estimated indirect damages are $11,260 (Table 5).

Problems Relating to Water Management

Recreation: The General Plan for Sioux City indicates a need for a park in the northeast part of the City. Structure A-2-4, with its added water for recreation, the basic recreational facilities and the extra land for the recreation area, would help satisfy this need.

Studies of use in several recreation areas in the Sioux City area were made. Reservation and swimming pool entries at Riverside Park totalled 65,348. No count was kept of small groups without reservations. If these were considered it is likely that attendance would total more than 100,000. In 1968, a traffic count at Snyder Bend Park showed 126,000 visitors. Little Sioux Park, in its second year of operation, had a 60,000 attendance. This park is located 35 miles from Sioux City. The nearest lake at the present time is near Salix, a distance of 18 miles. The present population of Sioux City is 89,000. It is projected to be 118,000 by 1980.

The public recreation development proposal included in this project would be easily accessible from all parts of the city and county, being located near the proposed outer belt drive. It would also be within a short distance of U. S. Highways 20 and 75.

## PROJECTS OF OTHER AGENCIES

In 1964 the Corps of Engineers installed channel improvements and levees along the Floyd River near the west boundary of the watershed. The installation of these measures has nearly eliminated the possibility of flooding to bottomlands from the Floyd River.

## PROJECT FORMULATION

The agreed upon project objectives which will maintain or accelerate the social and economic level of activity of the watershed community include:

1. Maintenance of soil productivity by the prevention of excessive sheet erosion.

2. Control or prevent gully erosion to the extent economically and physically feasible.

3. Reduce floodwater damage to the urban and built-up areas to provide 100-year protection.

4. Providing water-based recreation opportunities for residents of the local and surrounding areas.

Land treatment is considered as the basic step for reduction of soil erosion and runoff. The land treatment program outlined in this work plan was developed by the local sponsors and Service personnel. Accomplishments in the Districts during past years were used as a guide in determining what would be applied during the six year installation period.

There is a demand for additional housing in this part of the City. It is expected that such additional land in the watershed will be taken out of agricultural production and will be used for urban development.

The topography of the watershed provides numerous sites for structures. The structures will provide for reduction of damages from floodwater and sediment, and will stabilize waterways. Only structures that will benefit two or more landowners and that are economically justified are included as structural measures in the project.

There are three recreation areas located within or near Sioux City, none of which provide water-based recreation opportunities. The nearest lake is 18 miles from the City and does not offer many basic facilities for recreation activities. The Missouri River has had minimum use. It was, therefore, the desire of the local sponsoring organizations to include a water-based public recreation development as a part of the project.

Several alternative combinations of grade stabilization structures were considered before selecting those to be included in the plan. Based upon experiences of costs for structures at similar sites, head control required, and the effectiveness of the various types of structures in stabilizing the gullies and reducing downstream peak flows and sediment, the engineers determined the type most feasible for each individual site, or those best suited for a combination of sites. The costs of the structures and the amount of damages that would be prevented were of prime concern.

An alternative was studied for the size of pool for recreation. It would have given a larger pool but it was found that pumping of additional water from wells would be necessary to maintain its size. The sponsors indicated this would not be practical.

## WORKS OF IMPROVEMENT TO BE INSTALLED

### Land Treatment Measures

The farmers in the watershed are progressively installing land treatment measures. The project provides for a sound and effective land treatment program to be installed on most of the land on the remaining farms needing treatment during the six-year

project installation period.

Alternative methods of treatment are available. Those measures to be applied will be based on the decisions of the landowners after adequate consideration has been given to those alternatives that are available. For example, to control sheet erosion losses to permissible limits, an intensive cropping rotation with only moderate amounts of meadow may be used on Class IIIe lands that are level terraced and contour farmed. Where contouring alone is used on such land, the rotations must include a higher proportion of meadow and less of the grain and intertilled crops to offset effects of reduction in slope length due to terraces; or the land may be used for permanent pasture. Similar alternatives are available on other land classes. The level terraces have a further advantage, however, of reducing runoff and thus decreasing the amounts of needed treatments in downstream gullies. Other treatments such as grassed waterways and gully stabilizing structures will be needed in varying amounts depending somewhat upon other treatments selected.

Soil surveys, for use in farm planning and for development of land treatment needs, have been completed in the watershed. These soil surveys provide basic information for planning the definite and alternative land treatments.

Past experience in the watershed has been used as a guide in arriving at estimates of the combinations of land treatment measures that will be applied on the various farms.

Level terraces are planned for croplands where soils and topography are suitable and where determined practical by the district conservationist and the farmer. To date, 75 miles of level terraces have been installed.

Basin terraces are constructed level in pervious soils below steep areas that are protected with permanent grass cover. They are used to intercept hillside runoff and thus protect the downstream area from overland flow and erosion. Five miles have been installed to date.

Contour farming is used alone or in combination with terraces. Currently, 4,374 acres are being farmed on the contour.

Land treatment grassed waterways are natural watercourses which are shaped and seeded to protective vegetation by proper seedbed preparation, fertilizer application, and seeding of a suitable grass mixture. These waterways are dependent on stabilized grades to be provided by the downstream structural measure. Approximately 40 acres of waterways have been installed.

A pasture renovation program is underway in the watershed. Poor pastures are improved by seedbed preparation and seeding of suitable grass-legume mixtures. This provides better cover to reduce runoff and increases forage production. About 160 acres of pasture have been improved.

Land treatment grade stabilization structures are installed by farmers to stabilize gullies and waterways on their individual farms. The County has also used this type of structure to stabilize road ditches. Two of these structures have been installed.

The forest land treatment program consists of 30 acres of tree planting, with 30 acres of grazing control. These measures favor the maximum production of litter, humus, and forest cover. Technical assistance for additional treatments will be furnished by the Iowa Conservation Commission, Forestry Section, in cooperation with the U. S. Forest Service under the Cooperative Forest Management Program.

Wildlife plantings of food and cover are included in conservation plans in all instances where farmers agree to do so. One hundred forty-three acres of habitat, food, and cover plantings or improvements have been accomplished on District cooperator farms to date. It is anticipated that additional areas for wildlife will be improved adjacent to some of the impoundments of the proposed structures and in odd areas. This will be especially important where impoundments remove such cover by inundation.

Farmers will be encouraged to participate in fishery developments in the impoundments by cooperating with the State Conservation Commission or the Bureau of Sport Fisheries and Wildlife, in the proper stocking and management of the ponds.

Structural Measures

The structural measures included in this project will stabilize gullies, reduce floodwater damages to homes and business establishments in the part of town called Greenville, reduce cost of removal of sediment from streets, culverts, and road ditches and provide water for recreation and the accompanying recreational development.

Structural measures to be installed include 31 grade stabilization structures; five floodwater and sediment control structures; and one multiple purpose structure for floodwater and sediment control, and for public recreation. Twenty-two of the 31 grade stabilization structures incorporate floodwater detention and provide for sediment storage in their design; four are full flow drop inlet structures

including one that will replace an existing city street bridge; one is an inlet on an existing street culvert; and three are full flow chute spillways. The five floodwater and sediment control structures and the multi-purpose structure will also provide for some grade stabilization.

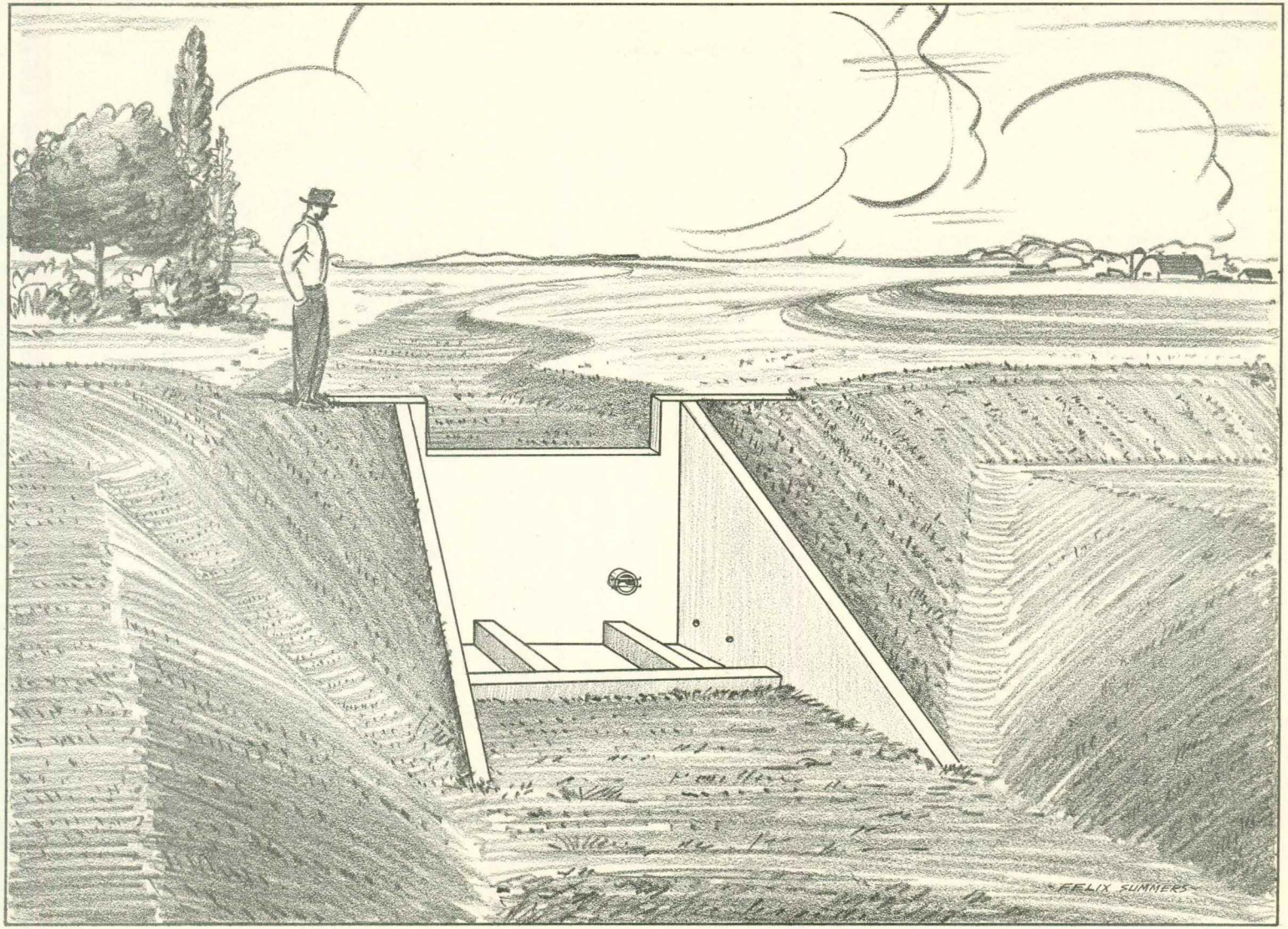
Drop Inlet Structure, Detention Type: This type of structure consists of a compacted earthfill dam and a principal spillway of pre-cast reinforced concrete pipe or corrugated metal pipe with suitable outlet. In many cases a hooded inlet is used in place of a vertical drop inlet. Storage capacity for sediment is provided to assure that the storage for temporary detention will be available during its expected life. All these structures will have 100-year sediment storage capacity.

Structures A-1, A-2, A-2-1, A-2-2, A-2-3, A-2-6, H-1-3, H-2-1, J-1, J-2, J-5, K-1, L-1, L-2, L-3, and M-1 are designed with corrugated metal pipe principal spillways that are planned for replacement some time after 50 years. Grade stabilization structures H-1, H-1-1, H-1-2, H-3-1, H-3-2, and J-3 are designed with reinforced concrete pipe. Floodwater retarding structure A-3 and multi-purpose structure A-2-4 are designed with reinforced concrete pipe. Sites A-1-1, B-1, C-1, and D-2 will use 30-inch reinforced concrete pipe and two stage risers to reduce release rates lower than that provided by 30-inch pipe which is the minimum size pipe used for class "c" floodwater and sediment control structures. Sketch SS-14 shows the type of outlet proposed for these four sites.

Structures A-1-1, A-3, B-1, C-1, and D-2 are classified as floodwater retarding and sediment control structures since their principal purpose is for control of floodwater and sediment.

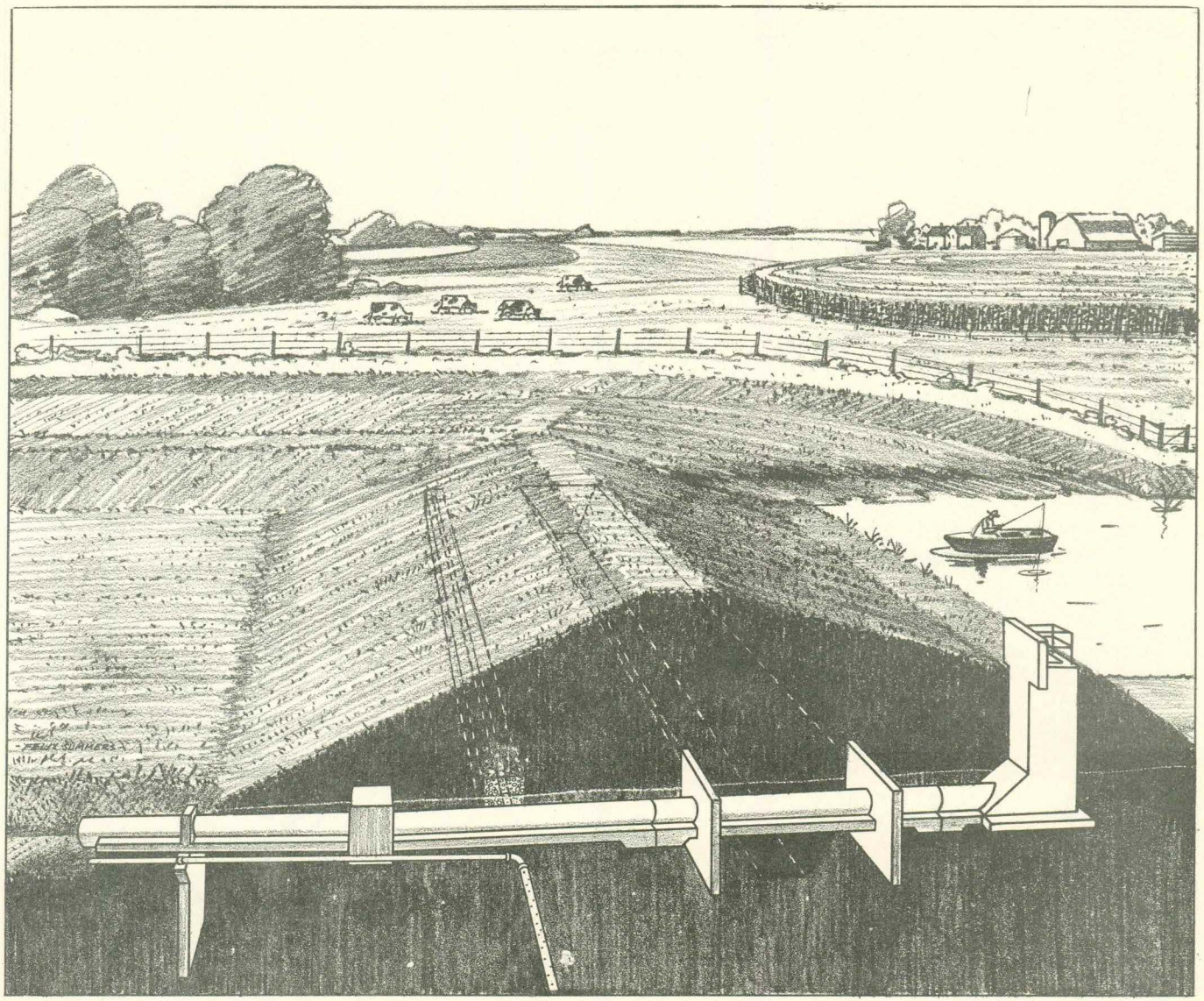
An open vegetative emergency spillway channel will be provided at one or both ends of each dam to convey the runoff from storms of greater magnitude than the design storm without causing over-topping of the dam. A drop inlet structure is illustrated in sketches SS-2A, SS-12, and SS-14, except that those with corrugated metal pipe spillways will have slotted flume outlets.

Structure A-2-4 is a multiple-purpose structure for flood prevention, sediment control, grade stabilization, and a public recreational development. A drawdown pipe and gate will be provided consisting of a cast iron gate with a geared mechanism operated from the top of the drop inlet riser and a 24-inch concrete pipe extending from the gate at the bottom of the riser into the lake. Estimates of submerged sediment storage requirements of 228 acre feet for the 100-year evaluation period would provide for an initial water pool area of 22.7 surface acres. Recreation water storage was then added to provide a surface area of 34 acres, or an increase of 51.2 percent in surface area. This added storage volume is 157 acre feet.



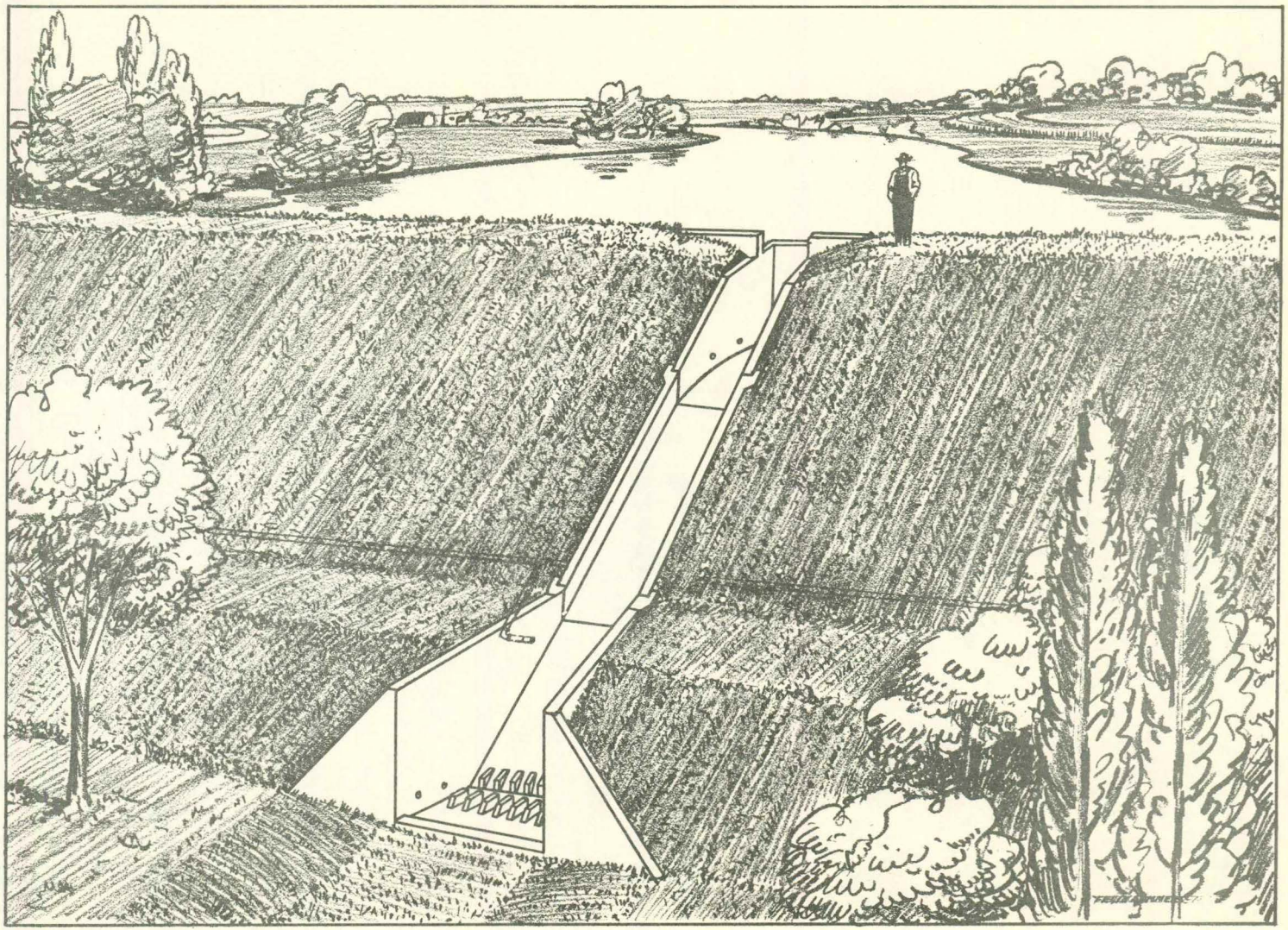

# Drop Spillway

USDA-SCS-LINCOLN, NEBR. 1965



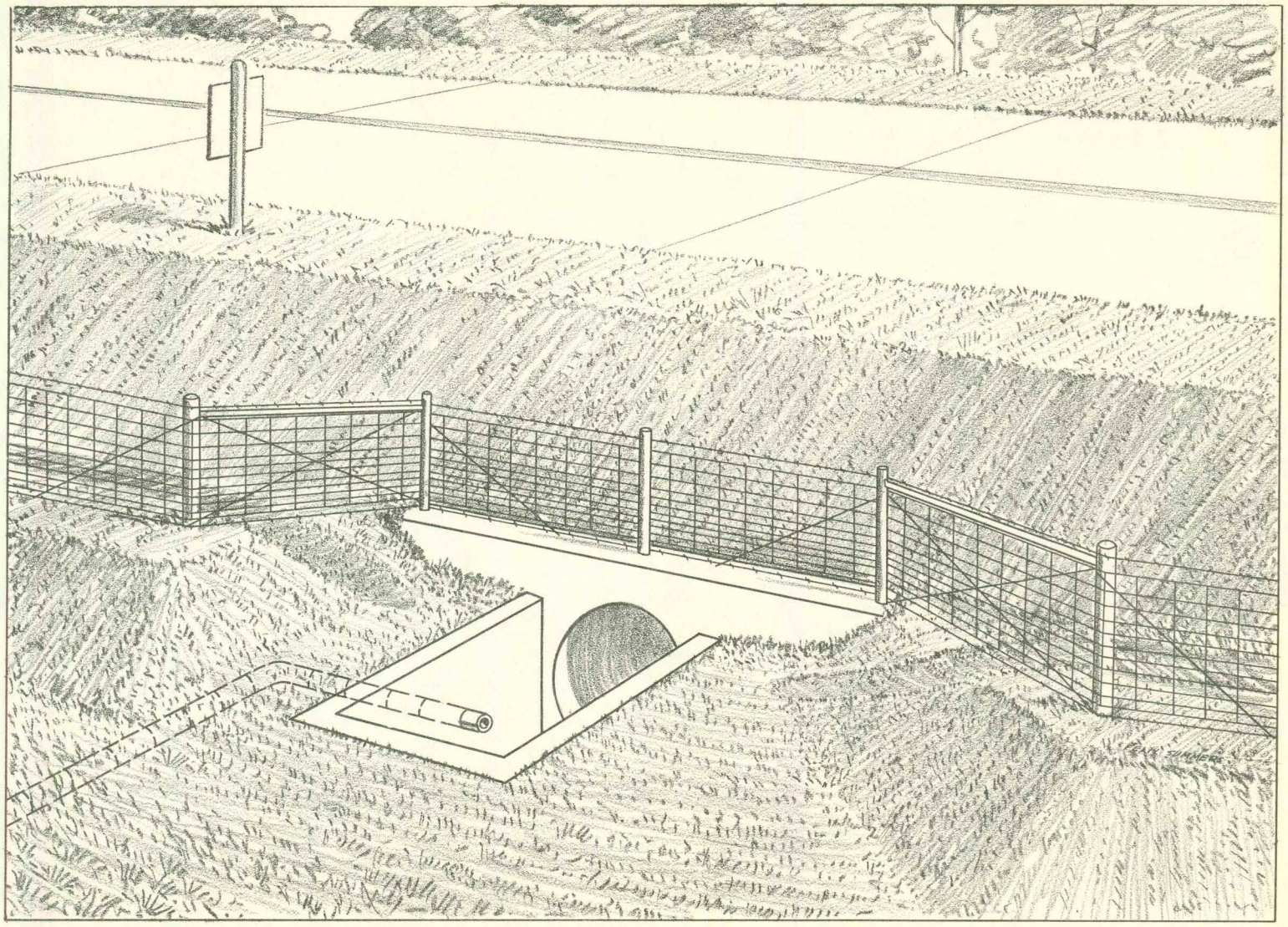
*Earth fill dam with concrete drop inlet and conservation pool.*

USDA-SCS-LINCOLN, NEBR. 1967



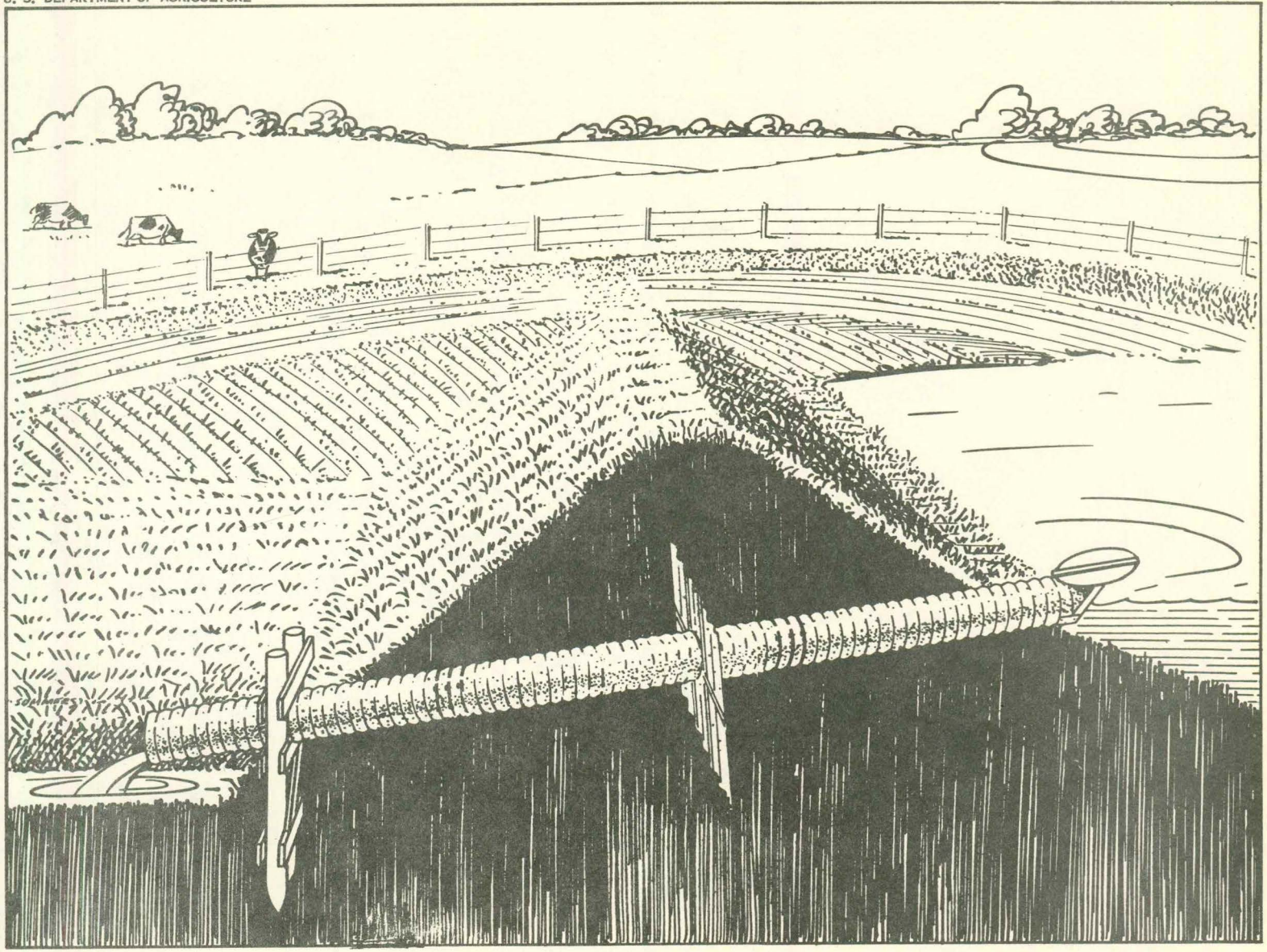
*Chute Spillway*

USDA-SCS-LINCOLN, NEBR. 1969



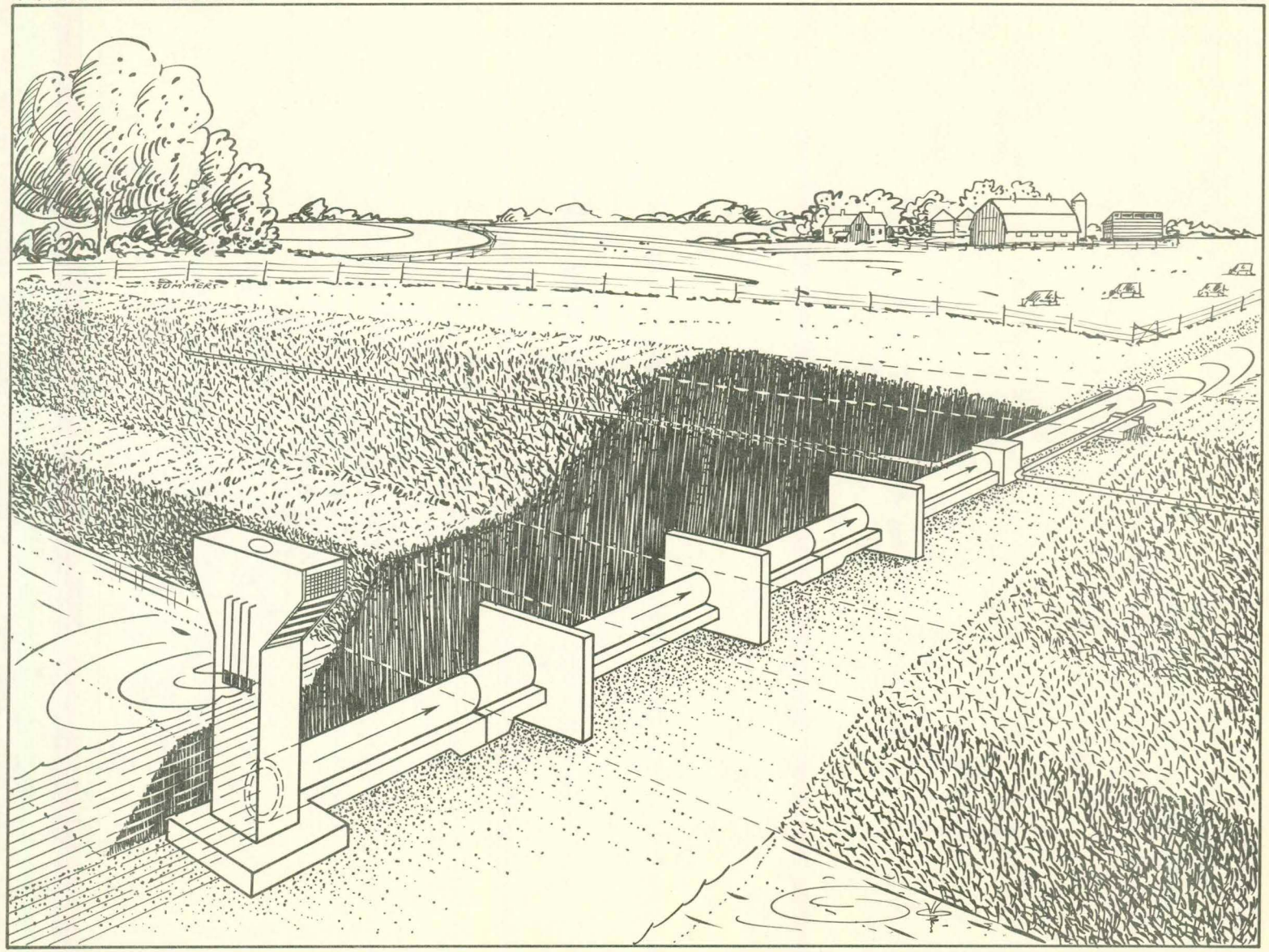
*Culvert box-inlet.*

USDA-SCS-LINCOLN, NEBR. 1965



*Metal pipe with hooded inlet.*

USDA-SCS-LINCOLN, NEBR. 1965



*Reinforced concrete pipe with flat top inlet.*

USDA-SCS-LINCOLN, NEBR. 1965

An analysis of inflow and seepage in structure A-2-4 shows that it will take approximately five years before the recreation pool will be filled and stable. During the first five years after the structure is built the seepage loss will be large and the surface area will be fluctuating and of little value for recreation. After five years the seepage loss should be quite small and the loss from evaporation less than the runoff into the reservoir resulting in a relatively stable pool.

The acres of land for the water resource improvement is estimated to be 177 acres.

Drop Inlet Structure, Full Flow: Structures H-1-2, H-2, J-4, and M-2 are quite similar to the drop inlet detention type, except that they are designed to discharge maximum peak flows from runoff without the need for sediment and temporary storage. The design of structure H-2 will provide for stabilizing the upstream gully and serve as a public road. The top width will be increased to serve this non-project purpose.

Box Inlet to Culvert: Structure A-2-7 is a concrete box inlet riser on an existing road culvert. It does not reduce the capacity of the culvert for flow of water, but reduces the gradient of the upstream watercourse. Features of this structure are shown in sketch SS-11. A guard rail not shown in sketch will be provided.

Chute Spillway: Structures A-2-5, A-4, and F-1 are compacted earth-fills with spillways of reinforced concrete. The spillway is designed to provide capacity for the peak flow of a 25-year frequency storm. Ordinarily, chute spillways will provide some storage for sediment; however, this is usually incidental to their normal purpose. Sketch SS-5 illustrates a chute spillway.

Drop Spillway: Structure D-1 is a full flow monolithic concrete structure with a weir notch. It is designed in the watercourse to drop the water from one level to another for gradient control and stabilization of the upstream gully or watercourse. It does not have floodwater retarding features. This type is illustrated in sketch SS-1.

Basic Recreation Facilities: Basic recreation facilities will be installed in order that public use of the water and adjacent land for recreation can become available to meet the estimated needs. The anticipated uses are quite varied, and therefore a variety of facilities are planned. Water and toilet facilities are included to meet the requirements of the State Health Department. Included, also are tree and shrub plantings and seedings in the light use areas surrounding the lake on the east and west sides to add to the scenic value and beauty of the area and give improved cover, food and habitat for wildlife. The basic facilities to be installed and for which cost sharing is planned with P.L. 566 and local funds are shown in Table 2B.

The Public Recreational Development (Figure 2) shows the general plan for the basic recreational facilities and the approximate taking lines for land purchase. The facilities will occupy an estimated 65 acres of land.

Fences will be installed at other than existing property lines where new boundaries are formed by the "taking lines". Public access to the park will be available only at designated public access points.

Preliminary studies indicate that water quality will be adequate for recreational uses including swimming.

The location of the structures and recreational development is shown on the project map (Figure 3). Tables 2, 2A and 3 set forth further data and details pertaining to costs, construction quantities, and design features of the structural measures.

### Mitigation Measures

Installation of the structural measures will cause loss of wildlife habitat in the watershed. The loss of this habitat will be mitigated through the establishment of 15 acres of wildlife plantings. These plantings will be located in Woodbury County outside the city limits and consist of shrubs and other perennials of various species. The area will be fenced to exclude livestock unless the areas are not accessible to grazing or trampling by livestock.

## EXPLANATION OF INSTALLATION COSTS

The project installation costs, as used in this work plan, include all costs of P.L. 566 and other funds, in cash or its equivalent, for installing all works of improvement for the project purposes of watershed protection, flood prevention, and recreation.

The costs of installing the land treatment measures includes all P.L. 566 and other costs for planning and applying the measures, both for technical assistance and for construction. This estimated cost is $90,300; it includes cost to the farmers, cost sharing from going agricultural and cooperative forestry programs, and technical assistance from State, Cooperative Forest Management, P.L. 46 and P.L. 566 funds. This is divided into $2,030 from P.L. 566 funds and $88,270 from other funds (Table 1).

Costs for the installation of forest land treatment measures are based on current costs of supervision, labor, equipment and materials needed to perform the particular measures. Costs for technical assistance in the installation of land treatment measures are based on an analysis of records of the Iowa Conservation Commission, Forestry Section.

Construction costs of the structural measures include all contract costs for their installation. A contingency cost was added to the engineer's cost estimate to provide for unforeseeable cost increases during construction. Based upon experiences to date in similar watershed work, the contingency cost was estimated to be 12 percent of the engineer's estimate.

The "Use of Facilities Method" for cost allocation, as set forth in the Economics Guide for Watershed Protection and Flood Prevention, was used to determine the costs to be assigned to flood prevention and those to be assigned to recreation for the multiple-purpose structure A-2-4. The storage capacity of 157 acre-feet of water that is provided for recreation compared with 660 acre-feet of storage for flood prevention gave an allocation of 19.2 percent for recreation and 80.8 percent for flood prevention.

These values were then adjusted to include the cost of a roadway that was needed on top of the dam for access to the recreational facilities. The added cost of providing this roadway was added to the above computed recreation cost and to the total structure cost. The combined structure cost including roadway gave an adjusted percentage of 79.9 percent to flood prevention and 20.1 percent to recreation. Therefore, the construction costs and engineering services costs of structure A-2-4 have been allocated to flood prevention and recreation in those ratios. However, the costs of the drawdown pipe and gate were allocated to recreation, since it is designed to serve only that purpose. The costs of the land rights except for flowage easements for A-2-4 have been allocated to recreation. The costs of flowage easements were allocated to flood prevention.

The installation costs of all other structural measures have been allocated to flood prevention since they serve only that purpose. Construction costs (contract costs) allocated to flood prevention will all be provided from P.L. 566 funds.

The construction costs of the recreational facilities will be cost shared 50 percent from P.L. 566 funds and 50 percent from local funds. An exception to this are any basic recreational facilities that are not eligible for cost sharing. These ineligible measures will be installed by the local sponsors at no cost to the Federal Government.

The construction cost of the wildlife habitat mitigation measures has been included in the construction cost of the structural measures in Woodbury County outside the City limits. The estimated construction cost of these measures is $1,800.

Engineering services include the direct cost of engineers and other technicians for surveys, investigations, design and preparation of

plans and specifications of structural measures. Engineering services costs for the structural measures, allocated to flood prevention, have been assigned to P.L. 566 funds. Cost sharing of the engineering services expected to be contracted for the eligible basic recreational facilities have been assigned 50 percent to P.L. 566 funds and 50 percent to local funds.

Land rights costs include all costs and expenditures made in acquiring land or easements, or the value of such lands if donated. These values are estimated by the sponsors with concurrence of the Service. The cost sharing of lands to be secured in fee title for the recreation development has been assigned 50 percent to P.L. 566 funds and 50 percent to local funds. The costs of all land rights for the flood prevention structures have been assigned to local funds. The costs of land surveys, flowage easements, title searches, recording of titles, etc., have also been assigned to local funds.

The project administration costs are P.L. 566 and other administrative costs associated with the installation of structural measures including the cost of contract administration, review of engineering plans prepared by others, government representatives, construction surveys, and necessary inspection service during construction to insure that structural measures are installed in accordance with plans and specifications.

Project administration costs have not been allocated, but have been assigned to P.L. 566 funds and local funds in the estimated amounts that the Service and sponsors will each incur in the installation of the project.

The drawdown pipe and gate for structure A-2-4 is a specific cost item for recreation. This $5,160 estimated construction cost will be shared $2,580 from P.L. 566 funds and $2,580 from local funds. The remaining construction costs of the multiple-purpose structure A-2-4 are estimated to be $156,340. This is divided into $140,630 from P.L. 566 funds and $15,710 from local funds.

The construction costs of the basic recreation facilities are estimated to be $217,680. Of this, $108,840 will be provided from P.L. 566 funds and $108,840 from local funds.

Engineering services costs for the basic recreational facilities are estimated to be $43,540. Of this amount $21,770 will be paid from P.L. 566 funds and $21,770 from local funds. The engineering services costs for all other structural measures are estimated to be $244,070 and will be provided from P.L. 566 funds.

The costs of land rights for structure A-2-4 and the public recreational development are $43,250 of which $21,200 will be provided from P.L.566 funds and $22,050 (includes $850 for land surveys, flowage easements,

title searches, etc.) from local funds. All other land rights for the remaining structural measures have an estimated value of $62,620 and will be provided from local funds. Of this amount, $750 is for land rights costs for mitigation measures.

The project administration costs are estimated to be $229,130. Of this amount, P.L. 566 funds will provide $210,510 and local funds $18,620.

Non-project costs are all additional costs resulting from changes of or additions to project works of improvement for non-project purposes such as altering a structure to permit its use as a roadway. These costs must be borne by the local organization as additional items of cost that are not considered in benefit-cost analysis, cost allocation, or cost-sharing computations nor credited as a part of the local share of the installation cost of the project measures. For structure H-2, the purpose of its use as a road crossing (non-project cost) and for stabilizing a gully (flood prevention cost) were considered to be of about equal importance; therefore the Service and the City will share equally in the construction costs and in a division of engineering services responsibilities for this structure. The construction costs will be shared $13,440 each by the Service and the City, and the value of $2,690 of engineering services to be performed by each. These and other land rights costs are shown in parentheses in Table 2 and are not included in total project costs in Table 1 or in annual costs in Table 4.

The total installation cost of all structural measures and the recreational development is $2,057,390 (Table 1). Of this amount, $1,805,200 will be provided from P.L. 566 funds. Local funds will provide $252,190.

A summary of the cost allocations and cost sharing is shown on Table 2A.

An estimated schedule of Federal and non-Federal obligations, by fiscal years, for land treatment and structural measures, is tabulated below:

| Fiscal Year | Structural Measures | | Land Treatment | | Total |
|---|---|---|---|---|---|
| | P.L.566 | Local | P.L.566 | Local | |
| 1 | $ 23,000 | $ 2,000 | $ 400 | $17,000 | $ 42,400 |
| 2 | 278,000 | 42,200 | 400 | 17,000 | 337,600 |
| 3 | 530,000 | 102,700 | 400 | 17,000 | 650,100 |
| 4 | 466,000 | 84,000 | 300 | 12,000 | 562,300 |
| 5 | 350,000 | 20,000 | 300 | 12,000 | 382,300 |
| 6 | 158,200 | 1,290 | 230 | 13,270 | 172,990 |
| Total | $1,805,200 | $252,190 | $2,030 | $88,270 | $2,147,690 |

## EFFECTS OF WORKS OF IMPROVEMENT

### Effects of Land Treatment Measures

The planned terraces and contour farming along with conservation cropping systems will effectively reduce sheet erosion on cropland where these practices are installed. The present rate of 4.4 tons per acre per year averaged for the entire upland area, including cropland, pasture, and other land uses, will be reduced to 3.1 tons per acre per year. This is a 30 percent reduction in sheet erosion. With the land treatment measures installed, 84 percent of the land in the watershed will be protected from damage by sheet erosion; portions of the remaining 16 percent will be partially protected by conservation treatment measures. Level terraces further will reduce water runoff and thereby reduce gully erosion and its sediment. The grassed waterways will reduce gully erosion and facilitate farming operations by eliminating existing non-crossable gullies. The planned land treatment measures will bring about further conservation benefits in the form of increased farm income; these benefits, however, have been evaluated only in the gully damage areas.

The forest treatment measures on 50 acres will enhance the hydrologic conditions and reduce runoff from those forest areas so treated. Additional wildlife plantings and cover to be established adjacent to impoundments in structures and in odd areas will aid in providing habitat for wildlife to compensate for losses of such cover in gullied areas included in the impoundments.

### Effects of Structural Measures

Benefits from the project have far-reaching effects on the inhabitants, city, lands, and facilities in the watershed. Of the 110 farms and many small acreages within the watershed, benefits from the reduction of gully erosion will accrue to 92 farms and several acreages. The runoff from 51 percent of the total drainage area of the watershed will be controlled by detention type storage structures.

The project will (1) have important effects in stabilizing the agricultural production and economic returns to farmers in the watershed, (2) provide a base for further enhancement and economic growth, (3) assist in maintaining the existing family type farm and (4) provide residents of the area with the opportunity to participate in water-based recreation activities. Reduced public expenditures for road repair and a stabilization of the tax base for units of local government will also result from the project.

Gully erosion damage is very costly in the urban area of the watershed. This is due to the high value of the land that is being affected.

The project developments will greatly improve this area for housing. Structural measures will stabilize many of these gullies. Maintenance costs for roads, bridges, etc., will be greatly reduced. Vegetation and trees will begin to grow in these controlled areas. This value cannot be evaluated but will beautify the area and is an aesthetic value to the project.

The Counties will realize reductions in damages to roads at ten locations. A reduction in the cost of replacing bridges at seven sites and reduction in damages to pipelines at seven locations will result from the project.

It is estimated that 4,700 acres of the watershed area will be benefited by the structural measures included in the project. This includes 300 acres of bottomland area subject to flooding and 4,400 acres of upland area with a gully erosion hazard.

The latest storm in which serious urban floodwater damage occurred was in 1955. In the Greenville area, nine blocks of houses and ten commercial units were damaged. Additional damage occurred to streets, sidewalks, storm sewers, yard fences, and automobiles.

In the area further north along U. S. Highway 75, the filling with sediment of the inlet channels leading over the Floyd River floodplain to the newly improved Floyd channel will be reduced about 90 percent. The reduced peak flood flows in these inlet channels will permit the use of closed storm sewers, or the use of smaller channels and smaller culverts to replace bridges; damages from up to 100-year frequency floods will be eliminated.

The major types of recreation will be picnicking, swimming, boating, and hiking. The main recreation season for use of the recreation area is about 100 days. The peak daily use over weekends and holidays may vary from 1,500 to 2,000 visitor days on the basis of the facilities provided. Total annual use for the season is estimated to be 75,000 visitor days. The value per visitor day is $1.50.

The State Health Department has stated that the water will be of a quality needed for recreation. They anticipate no problems of contamination and feel that the sanitary measures included in the recreational facilities are adequate.

The sediment storage pools in 27 of the structures will provide water storage and recreation use in those structures where the water yield is large enough to maintain an adequate pool area and depth. Sediment accumulation in the later years of the project period will greatly diminish the recreation use.

The pools vary in size from 2 to 15 acres and are of sufficient depth to maintain fish. Farmers have indicated that they will secure fish for stocking, mostly bass and bluegill and some catfish from various sources that are available. Many of the ponds will be fenced by farmers and wildlife food and cover plantings established near the ponds and in odd corners. These ponds and surrounding areas will provide farm famililies and others with recreation opportunities such as fishing, swimming, boating, picnicking, hunting, etc. No monetary value of these incidental recreation benefits has been estimated.

The sponsoring local organizations are aware that incidental recreation use may require attention and consideration for installing sanitary facilities. If the use becomes so concentrated that toilet facilities are required for protection of health, they will either provide such facilities or restrict the use of the water pool areas. It is not intended that drinking water be available at any of the sites. The quality of water in the sediment pools will periodically be considered by the sponsors for adequacy of meeting health standards for such contact sports as swimming, water skiing, etc. Primary concern in this regard will be given to barnyard drainage and the use of herbicides, insecticides, etc.

The 15 acres of wildlife habitat plantings will be used to mitigate the destruction of habitat in the impoundments. These mitigation measures along with the wildlife food and cover plantings established by individual farmers will improve the wildlife habitat in the watershed.

The impoundments of the structures, amounting to about 186 acres of water surface area, should help attract the many kinds of waterfowl and shore birds which have traditionally used the Missouri River Subflyway of the Central Flyway.

Secondary benefits will accrue within the immediate zone of influence of the project. They include (1) the transporting, processing, and marketing of goods and services that produce the primary benefits, and (2) the supplying materials and services which make possible the maintenance of the net returns which result from the installation of the project. These benefits accrue primarily to processors and merchants in the community providing services to farmers.

## PROJECT BENEFITS

The annual evaluated gully erosion damage to urban and agricultural land and improvements of $102,940 will be eliminated (Table 5).

The average annual evaluated floodwater damage to the urban area of $3,530 will be eliminated (Table 5).

Sediment damages evaluated at $20,300 will be reduced to $2,030 or a benefit of $18,270 (Table 5).

Indirect damages of $11,260 which accompany the direct damages, will be reduced to $820 giving a benefit of $10,440 (Table 5).

Benefits accruing to the project from the public recreational development are estimated to have an annual value of $87,620 (Table 6).

The average annual value of local secondary benefits are $11,670 (Table 6). Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation.

The total of the average annual primary and secondary benefits resulting from the project is $234,470. Of this amount, $234,030 or 99.8 percent will be derived from the structural measures.

## COMPARISON OF BENEFITS AND COSTS

The average annual primary flood prevention benefits from the structural measures, excluding local secondary benefits, are $222,360; this compared with the average annual cost of $126,960 gives a benefit-cost ratio of 1.8 to 1.0.

The average annual primary and local secondary flood prevention benefits from the structural measures in the project of $234,030 compared with the average annual cost of $126,960 give a benefit-cost ratio of 1.8 to 1.0 (Table 6).

## PROJECT INSTALLATION

The project measures will be installed during a six-year project installation period. The local sponsoring organizations and the Service will coordinate the installation of the structural measures in the project with the planning and application of land treatment measures on the individual farms. The planning and application of land treatment measures will progress as rapidly as resources permit and will be of such intensity and scope as to meet the hydrologic and sediment design criteria of the structural measures.

### Land Treatment Measures

An intensive program of education and demonstrations, along with group planning meetings and direct assistance to farmers, will be used to facilitate the installation of the needed treatment measures.

The District governing bodies will schedule meetings to facilitate carrying out the planned program, set priorities of farmers to be assisted, make periodic checks on completed measures and maintenance

needs, and otherwise assist to further the land treatment phase of the watershed project. Details of each individual landowner's portion of planned land treatment measures will be defined in the cooperator's basic conservation plan.

Land treatment measures will be installed by individual farmers or small groups of farmers working together. The current Agricultural Conservation Program will be utilized as funds may be available for those practices eligible for cost-sharing assistance. Service technicians working with the District will assist with the planning and application of the land treatment measures.

The current land treatment program is being planned and applied by the landowners and District with technical assistance provided by the Service under the authority of Public Law 46. In order that the planned land treatment measures may be installed during the project installation period, an acceleration of the present rate of application will be required. Additional technical assistance for this purpose will be made available by the Service from P.L. 566 funds.

Forest land treatment measures will be installed by the landowners with technical assistance furnished by the Iowa Conservation Commission, Forestry Section, in cooperation with the U. S. Forest Service.

Additional land treatment measures will more completely protect the remaining watershed lands and it is expected that these needed additional measures will be installed by landowners in the years following the project installation period. It is expected that normal going program assistance will be available for this installation.

Structural Measures

The installation of structural measures will follow a sequence such that upstream works of stabilization and waterflow control will precede the installation of those that lie downstream. In this manner the sediment storage capacity and the temporary retarding pools at downstream sites can be designed and installed at the least cost for the flood prevention purpose. Project costs and evaluations of measures have proceeded on that basis in this work plan.

Engineering services for the basic recreational facilities will be contracted for by the City. An 'Agreement for Engineering Services' will be executed by the Service and the City setting forth work to be accomplished, estimated costs, and payments and/or reimbursements by each party to meet the cost sharing requirements, etc.

The design of structure H-2 will incorporate features for both a road crossing purpose, which is considered a non-project purpose, and for the project purpose of flood prevention.

For structure H-2 the Service will make or pay for the necessary site investigations of foundation and borrow areas, the soils mechanics laboratory work, the preparation of designs and specifications for the earth fill and the accompanying foundation drainage, the development of flood routings of storage type structures and the associated hydraulic designs, the establishment of elevations for the inlets and outlets of the principal spillways and the preparation of detailed structure designs.

The City will make or pay for all needed site surveys for structure designs and for the establishment of vertical approach curves to establish the ends of fill to be included in the project. The City will provide plans and specifications for the road purpose and will consult with the Service to assure that all matters pertaining to the roadway design requirements are included in the plans.

The Service will stake out the works of improvement to be installed, and will conduct inspection services to assure that the work is installed in accordance with the drawings and specifications.

The sponsor will review and approve the drawings. The sponsor will make periodic or such frequent inspections and checks during construction as it deems attention is needed.

Engineering services for all structural measures will be provided or contracted for by the Service, except the recreational facilities.

All structural measures will be installed by contract. Legal authorities, facilities and funds are available to the City, Districts and Counties for securing land rights and installing structural measures. The Service is requested and agrees to award and administer contracts for all structural measures and the basic recreational facilities.

A 'Project Agreement for Construction of Structural Measures' will be executed for each contract unit of work prior to the issuance of invitation to bid.

For structure A-2-4 the agreement will be executed by the Service, Woodbury District and the City. Agreements for structures A-1-1, A-2-4, A-2-6, A-2-7, A-3, B-1, C-1, D-1, D-2, F-1, H-1-1, H-1-3 and H-2 will be executed by the Service, Woodbury District and the City.

Agreements for structures L-1, M-1 and M-2 located in Plymouth County will be executed by the Service, the Plymouth District and Plymouth County. The agreements for structures A-1, A-2, A-2-1, A-2-2, A-2-3, A-2-5, A-4, H-1, H-2-2, H-3-1, H-3-2, J-1, J-2, J-3, J-4, J-5, K-1, L-2 and L-3 and wildlife mitigation measures in Woodbury County that lie outside the city limits will be executed

by the Service and the Woodbury District. Each agreement will set forth details pertaining to the responsibilities of each party, such as work to be accomplished, estimated costs, cost sharing, contract administration, etc.

The Service will develop plans for the planting of mitigating wildlife food and cover. Consideration will be given to State Conservation Commission criteria. Woodbury District has requested and it is agreed that the Service will award and administer contracts for these plantings.

The Plymouth District will acquire land rights for structures L-1, M-1 and M-2. If the power of eminent domain is required to obtain land rights for these structures Plymouth County has this power and will use it. Woodbury District will acquire land rights for structures A-1, A-2, A-2-1, A-2-2, A-2-3, A-4, H-1, H-2-2, H-3-1, H-3-2, J-1, J-2, J-3, J-4, J-5, K-1, L-2 and L-3 and for the wildlife mitigation measures. Woodbury County will use their power of eminent domain if necessary to acquire these rights. The City will acquire land rights for the other structures A-1-1, A-2-4, A-2-5, A-2-6, A-2-7, A-3, B-1, C-1, D-1, D-2, F-1, H-1-1, H-1-3 and H-2. The City has the power of eminent domain and will use it as necessary to acquire these land rights.

A 'Land Rights Agreement' will be executed between the Service and the City for structure A-2-4 and the adjacent land for the recreational facilities. This land does not include lands occupied by structure A-2-5 and its reservoir. These lands will be acquired by the City as shown on Figure 2 but cost sharing with P.L. 566 funds will not be provided. This agreement will set forth estimated costs, obligations and lands to be acquired, responsibilities of each party, such as prior land appraisals, negotiations with landowners, acquisition of lands, and payments and/or reimbursement to effectuate the agreed upon cost sharing.

A 'Project Agreement' for the basic recreational facilities will be executed between the Service and the City. It will set forth the facilities to be installed, estimated costs, and obligations and responsibilities of each party for payments and/or reimbursements to meet cost sharing requirements, etc.

Fourteen construction units have been established in order to provide maximum flexibility in establishing a sequence for installing the structural measures (Table 7). Land rights for all structural measures in any one construction unit will be obtained before a project agreement is executed for the installation of any of the structural measures within that construction unit.

## FINANCING PROJECT INSTALLATION

Individual farmers will assume the cost of installing land treatment measures with such cost-sharing assistance as may be available under the provisions of the Agricultural Conservation Program or any other going agricultural cost-sharing programs.

The cost of installing the non-forestry land treatment measures is estimated to be $86,000. This includes $2,030 for technical assistance to be provided by the Service from P.L. 566 funds and $83,970 to be provided by the landowners with cost-share assistance from going agricultural programs.

The cost of installing forest land treatment measures is $4,300. Technical assistance to landowners for the installation of forestry measures estimated to cost $500 will be provided by the State Conservation Commission and the U. S. Forest Service through the Cooperative Forest Management Program. The estimated cost of $3,800 for installing the treatment measures will be paid by the landowners using such cost share assistance as may be available from state or Federal forestry and agricultural programs.

The Service will assume the entire construction costs of all structures except H-2, A-2-4 and the basic recreational facilities. The Service will cost share with the City in the construction cost of these three measures as set forth in a previous section, "Explanation of Installation Costs".

Land rights for mitigation measures and for structural measures other than for structures H-2, A-2-4 and the basic recreational facilities are expected to be donated by the concerned landowner or otherwise acquired by the City or by Districts with funds that will be available.

It is expected that the City will have funds available when needed for cost sharing of structures H-2, A-2-4, and the basic recreational facilities. This will be handled by budgeting the necessary tax monies the year prior to construction.

Federal assistance for installing the works of improvement on the non-Federal land, as described in this work plan, will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, 68 Stat. 666, as amended).

This work plan does not constitute a financial document to serve as a basis for the obligation of Federal funds. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

## PROVISIONS FOR OPERATION AND MAINTENANCE

### Land Treatment Measures

Land treatment and forestry measures will be maintained by the individual landowners and/or operators as prescribed in the conservation plans developed between the farmers and the District. Technical assistance will be made available through the District by the Service and by the Iowa Conservation Commission, Forestry Section, in cooperation with the U. S. Forest Service through the Cooperative Forest Management Program.

### Structural Measures

Structural measures and basic recreational facilities included in this project are planned and designed to serve project objectives. The total benefits to be derived from the installation of structural measures and recreational facilities cannot usually be realized unless the measures are operated and maintained in such a manner that they will serve the full purpose for which they were intalled. The program for operation and maintenance consists of:

1. An agreed-to plan which will provide adequate and sound arrangements for proper operation, timely inspection, and prompt and appropriate performance of needed maintenance; financing the costs of operation and maintenance; and the maintaining of records reflecting the actions required and taken.

2. The carrying out of the provisions of the agreed-to plan in a manner consistent with the spirit, intent, and purpose of the plan and project.

Structures located in Woodbury County, outside of the City limits of Sioux City will be operated and maintained by the Woodbury District. A sub-district will be organized in accordance with Iowa law to raise the necessary funds for this purpose.

The mitigation measures will be operated and maintained by the Woodbury District. This will be carried out by the farmer under an amendment to the Farmer-District Agreement.

Structures located in Plymouth County will be operated and maintained by Plymouth County by levying taxes as needed upon agricultural lands in the County in accordance with Iowa law. This levy is not to exceed one-quarter mill per year.

The structural measures that are located within the City limits of Sioux City and the basic recreational facilities will be operated and maintained by the City, using general tax revenue funds.

Inspection of the structural measures and recreational facilities will be made annually by the local sponsoring organizations and the Service for three years after the structure is completed. After the third year, the annual inspections will be made by the local sponsors. Additional inspections will be carried out following a severe storm or any other unusual condition that might adversely affect the structural measures. These inspections will be made to determine maintenance needs and will include the following determinations:

1. Rodent damage to earth fills; may need refilling, rodent control, etc.

2. Condition of emergency spillways and earth fills including vegetative cover and its needed improvement; may need filling of rills, reseeding or sodding, prevention of grazing, etc.

3. Needs for removal and disposal of debris in the sediment and temporary pools.

4. Condition of the principal spillway; may need calking, replacing concrete sections of pipe, adding riprap, etc.

5. It is anticipated that corrugated metal pipes used for principal spillways in structures A-1, A-2, A-2-1, A-2-2, A-2-3, A-2-6, H-1-2, H-1-3, H-2-1, J-1, J-2, J-5, K-1, L-1, L-2, L-3, and M-1 will need to be replaced in about 50 years. When the principal spillways are replaced in structures L-1 and L-3 they will be raised to provide 100-year submerged sediment.

6. Check condition of recreation facilities for repair and maintenance and see that work needing to be done is completed, such as making road repairs, repairs or replacements of picnic tables, shelters, water and sanitary facilities, etc.

A report of the inspection findings will be provided to the Service. When operation and maintenance is not being properly carried out, the matter will be brought to the attention of the sponsoring local organizations.

Regulations governing the use of the lake and park area will be those enforced by the City.

The lease of land for concessions will be permitted for essential purposes such as the sale of lunches, soft drinks, bait, gas, oil,

swimming attire, rental of boats, motors, etc., and to provide life-guard service.

The City does not plan to charge an admission fee. However, it may be desirable to make such charges at some future time. Such fees may not produce revenues in excess of the City's requirement to amortize their initial investment and to provide adequate operation, maintenance and supervision. The City in such event will establish a schedule of maximum admission or user fees which may be charged by a private concessionnaire(s) where involved. The schedules of admission and user fees together with other requirements for operation and maintenance of the recreational facilities must be mutually agreed to by the City and the Service and set forth in the Operation and Maintenance Agreement, or amendments thereto.

The basic recreational facilities will be installed, operated, and maintained in accordance with requirements of State and local health regulations. The operation and maintenance agreeement for the recreational facilities will be executed by the City and the Service.

The estimated average annual operation, maintenance, and replacement costs are $20,860 (Table 4). This includes $4,250 for the structural measures, and $11,940 for the basic recreational facilities, $4,000 is for replacement costs of basic facilities, and $670 for replacement of corrugated metal pipe spillways in 17 structures.

# TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Bacon Creek Watershed, Iowa

| Installation Cost Item | Unit | Number | Estimated Cost (Dollars) 1/ | | |
|---|---|---|---|---|---|
| | | Non-Fed. Land | PL-566 Non-Federal | Other Land | Total |
| (1) | (2) | (3) | (4) | (5) | (6) |
| LAND TREATMENT | | | | | |
| Soil Conservation Service | | | | | |
| Cropland | Ac. | 975 | - | 72,420 | 72,420 |
| Pasture Land | Ac. | 40 | - | 2,000 | 2,000 |
| Wildlife Habitat Management | Ac. | 2 | - | 100 | 100 |
| Technical Assistance | | | 2,030 | 9,450 | 11,480 |
| SCS Subtotal | | | 2,030 | 83,970 | 86,000 |
| Forest Service | | | | | |
| Woodland | Ac. | 50 | - | 3,800 | 3,800 |
| Technical Assistance | | | - | 500 | 500 |
| FS Subtotal | | | - | 4,300 | 4,300 |
| TOTAL LAND TREATMENT | | | 2,030 | 88,270 | 90,300 |
| STRUCTURAL MEASURES | | | | | |
| Construction | | | | | |
| Soil Conservation Service | | | | | |
| Grade Stab. Structures | No. | 31 | 814,340 | - | 814,340 |
| Floodwater Retarding & Sediment Constrol Str. | No. | 5 | 241,260 | - | 241,260 |
| Multi-Purpose Struc. A-2-4 | No. | 1 | 143,210 | 18,290 | 161,500 |
| Basic Recreation Fac. | No. | 1 | 108,840 | 108,840 | 217,680 |
| Subtotal - Construction | | | 1,307,650 | 127,130 | 1,434,780 |
| Engineering Services | | | | | |
| Soil Conservation Service | | | 265,840 | 21,770 | 287,610 |
| Subtotal - Engineering | | | 265,840 | 21,770 | 287,610 |
| Project Administration | | | | | |
| Soil Conservation Service | | | | | |
| Construction Inspection | | | 169,680 | 3,630 | 173,310 |
| Other | | | 40,830 | 14,990 | 55,820 |
| Subtotal - Administration | | | 210,510 | 18,620 | 229,130 |
| Other Costs | | | | | |
| Land Rights | | | 21,200 | 84,670 | 105,870 |
| Subtotal - Other | | | 21,200 | 84,670 | 105,870 |
| TOTAL STRUCTURAL MEASURES | | | 1,805,200 | 252,190 | 2,057,390 |
| T O T A L P R O J E C T | | | 1,807,230 | 340,460 | 2,147,690 |
| SUMMARY | | | | | |
| Subtotal SCS | | | 1,807,230 | 336,160 | 2,143,390 |
| Subtotal FS | | | - | 4,300 | 4,300 |
| T O T A L P R O J E C T | | | 1,807,230 | 340,460 | 2,147,690 |

1/ Price base: 1970

Date: November 1970

## TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

Bacon Creek Watershed, Iowa

| Measures | Unit | Applied to Date | |
|---|---|---|---|
| | | Amount | Value 1/ (Dollars) |
| (1) | (2) | (3) | (4) |
| Soil Conservation Service | | | |
| Land Treatment Measures | | | |
| Contour Farming | Ac. | 4,374 | 8,750 |
| Grassed Waterways | Ac. | 40 | 12,000 |
| Terraces, Level | Mi. | 75 | 56,250 |
| Terraces, Basin | Mi. | 5 | 10,000 |
| Grade Stabilization Structures | No. | 2 | 20,000 |
| Pasture & Hayland Planting | Ac. | 160 | 8,000 |
| Wildlife Habitat Management | Ac. | 143 | 7,150 |
| Conservation Plans Prepared | No. | 38 | - |
| Conservation Plans Revised | No. | - | - |
| District Cooperators | No. | 70 | - |
| Forest Service | | | |
| Tree Planting (open land) | Ac. | 22 | 1,700 |
| Grazing Control | Ac. | 22 | 1,200 |
| TOTAL | xx | xx | 125,050 |

1/ Price Base: 1970

Date: November 1970

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Bacon Creek Watershed, Iowa

(Dollars)[1/]

| Item | Installation Cost P.L. 566 Funds | | | | Installation Cost - Other Funds | | | | | Total Installation Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Construction | Engineering | Land Rights | Total P.L.566 | Construction | Engineering | Land Rights | Water Rights | Total Other | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| A-1 | 31,380 | 6,200 | | 37,580 | | | 800 | | 800 | 38,380 |
| A-1-1 | 32,140 | 6,430 | | 38,570 | | | 550 | | 550 | 39,120 |
| A-2 | 19,510 | 3,830 | | 23,340 | | | 1,050 | | 1,050 | 24,390 |
| A-2-1 | 35,840 | 7,170 | | 43,010 | | | 950 | | 950 | 43,960 |
| A-2-2 | 41,780 | 8,350 | | 50,130 | | | 1,500 | | 1,500 | 51,630 |
| A-2-3 | 23,860 | 4,770 | | 28,630 | | | 1,050 | | 1,050 | 29,680 |
| A-2-5 | 23,070 | 4,620 | | 27,690 | | | 150 | | 150 | 27,840 |
| A-2-6 | 17,140 | 3,430 | | 20,570 | | | 550 | | 550 | 21,120 |
| A-2-7 | 7,500 | 1,500 | | 9,000 | | | 50 | | 50 | 9,050 |
| A-3 | 100,690 | 20,140 | | 120,830 | | | 17,400 | | 17,400 | 138,230 |
| A-4 | 24,660 | 4,860 | | 29,520 | | | 300 | | 300 | 29,820 |
| B-1 | 47,040 | 9,410 | | 56,450 | | | 2,450 | | 2,450 | 58,900 |
| C-1 | 36,180 | 7,230 | | 43,410 | | | 1,540 | | 1,540 | 44,950 |
| D-1 | 9,300 | 1,860 | | 11,160 | | | 50 | | 50 | 11,210 |
| D-2 | 48,050 | 9,610 | | 57,660 | | | 2,700 | | 2,700 | 60,360 |
| F-1 | 22,060 | 4,410 | | 26,470 | | | 150 | | 150 | 26,620 |
| H-1 | 38,300 | 7,660 | | 45,960 | | | 1,000 | | 1,000 | 46,960 |
| H-1-1 | 36,400 | 7,280 | | 43,680 | | | 1,800 | | 1,800 | 45,480 |

Table 2 - Estimated Structural Cost Distribution (continued)

Bacon Creek Watershed, Iowa

(Dollars)[1/]

| Item | Installation Cost P.L. 566 Funds | | | | Installation Cost - Other Funds | | | | | Total Installation Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Construction | Engineering | Land Rights | Total P.L. 566 | Construction | Engineering | Land Rights | Water Rights | Total Other | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| H-1-2 | 8,620 | 1,730 | | 10,350 | | | 50 | | 50 | 10,400 |
| H-1-3 | 23,970 | 4,790 | | 28,760 | | | 1,950 | | 1,950 | 30,710 |
| H-2 | 13,440 | 2,690 | | 16,130 | | | 780 | | 780 | 16,910 |
| | | | | | (13,440) | (2,690) | (780) | | (16,910) | (16,910)[2/] |
| H-2-1 | 29,790 | 5,960 | | 35,750 | | | 1,100 | | 1,100 | 36,850 |
| H-2-2 | 45,610 | 9,050 | | 54,660 | | | 4,750 | | 4,750 | 59,410 |
| H-3-1 | 44,350 | 8,870 | | 53,220 | | | 1,250 | | 1,250 | 54,470 |
| H-3-2 | 33,380 | 6,670 | | 40,050 | | | 1,750 | | 1,750 | 41,800 |
| J-1 | 27,690 | 5,460 | | 33,150 | | | 2,000 | | 2,000 | 35,150 |
| J-2 | 23,970 | 4,790 | | 28,760 | | | 3,400 | | 3,400 | 32,160 |
| J-3 | 58,460 | 11,700 | | 70,160 | | | 4,800 | | 4,800 | 74,960 |
| J-4 | 19,040 | 3,810 | | 22,850 | | | 50 | | 50 | 22,900 |
| J-5 | 12,100 | 2,420 | | 14,520 | | | 900 | | 900 | 15,420 |
| K-1 | 18,140 | 3,630 | | 21,770 | | | 950 | | 950 | 22,720 |
| L-1 | 22,850 | 4,570 | | 27,420 | | | 600 | | 600 | 28,020 |
| L-2 | 16,350 | 3,270 | | 19,620 | | | 1,400 | | 1,400 | 21,020 |
| L-3 | 15,790 | 4,160 | | 19,950 | | | 900 | | 900 | 20,850 |
| M-1 | 24,190 | 4,850 | | 29,040 | | | 1,900 | | 1,900 | 30,940 |

Table 2 - Estimated Structural Cost Distribution (continued)

Bacon Creek Watershed, Iowa

(Dollars)[1/]

| Item | Installation Cost P.L. 566 Funds | | | | Installation Cost - Other Funds | | | | | Total Installation Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Construction | Engineering | Land Rights | Total P.L.566 | Construction | Engineering | Land Rights | Water Rights | Total Other | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| M-2 | 22,960 | 4,590 | - | 27,550 | - | - | 50 | | 50 | 27,600 |
| A-2-4 | 140,630 | 31,270 | 16,260 | 188,160 | 15,710 | - | 16,260 | | 31,970 | 220,130[3/] |
| Drawdown Pipe & Gate | 2,580 | 1,030 | - | 3,610 | 2,580 | - | - | | 2,580 | 6,190 |
| Basic Recreation Facilities | 108,840 | 21,770 | 4,940 | 135,550 | 108,840 | 21,770 | 5,790[4/] | | 136,400 | 271,950 |
| Subtotal | 1,307,650 | 265,840 | 21,200 | 1,594,690 | 127,130 | 21,770 | 84,670 | | 233,570 | 1,828,260[5/] |
| | | | | | (13,440) | (2,690) | (780) | | (16,910) | (16,910)[2/] |
| Project Administration | xx | xx | xx | 210,510 | xx | xx | xx | | 18,620 | 229,130 |
| | | | | | | | | | (2,150) | (2,150)[2/] |
| GRAND TOTAL | 1,307,650 | 265,840 | 21,200 | 1,805,200 | 127,130 | 21,770 | 84,670 | xx | 252,190 | 2,057,390 |
| | | | | | (13,440) | (2,690) | (780) | | (19,060) | (19,060)[2/] |

1/ Price base - 1969.
2/ Non-project costs for road purposes.
3/ Roadway cost for access to recreational facilities is included.
4/ Includes $850 for land surveys, flowage easements, title search, etc.
5/ Includes $2,550 of mitigating measures to replace habitat losses, for wildlife, i.e., lands, plantings and fencing.

Date: November 1970

TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY

Bacon Creek Watershed, Iowa

(Dollars) 1/

| Item | COST ALLOCATION | | | COST SHARING | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PURPOSE | | | P.L. 566 FUNDS | | | OTHER FUNDS | | |
| | Flood Prevention | Recreation | Total | Flood Prevention | Recreation | Total | Flood Prevention | Recreation | Total |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| 36 single purpose flood prevention structures | 1,329,990 | - | 1,329,990 | 1,267,370 | - | 1,267,370 | 62,620 | - | 62,620 |
| 1 multiple purpose structure A-2-4 | 149,900 | 70,230 | 220,130 | 149,900 | 38,260 | 188,160 | - | 31,970 | 31,970 |
| 1 drawdown pipe & gate | - | 6,190 | 6,190 | - | 3,610 | 3,610 | - | 2,580 | 2,580 |
| Basic recreation facilities | - | 271,950 | 271,950 | - | 135,550 | 135,550 | - | 136,400 | 136,400 |
| GRAND TOTAL | 1,479,890 | 348,370 | 1,828,260 | 1,417,270 | 177,420 | 1,594,690 | 62,620 | 170,950 | 233,570 |

1/ Price Base: 1970

Date: November 1970

TABLE 2B - RECREATIONAL FACILITIES

ESTIMATED CONSTRUCTION COSTS
Bacon Creek Watershed, Iowa

(Dollars) 1/

| Item | Number | Estimated Unit Cost | Total Construction Cost |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| 1. Drives & Parking Areas | | | |
| a. 5600' of 24' Drive (6" Gravel) | 2,500 cu.yds. | $4 | $ 10,000 |
| b. 2500 sq.ft. of Parking w/6" Gravel | 460 cu.yds. | 4 | 1,840 |
| c. Parking Posts | 300 | 2.50 | 750 |
| d. Clearing of Trees | Lump Sum | | 10,000 |
| e. Grading & Leveling of Land | Lump Sum | | 30,000 |
| 2. Hiking Trails | | | |
| a. 11,600 ft. of 4' Trail w/3" Gravel & includes necessary culverts & crossings | 11,600 ft. | 2.20 | 25,720 |
| b. Labor - Grading & Laying Gravel | Lump Sum | | 1,500 |
| c. Lookout Shelters | 2 | 1,200 | 2,400 |
| 3. Fencing | | | |
| a. Boundary Fence | 18,000 ft. | .75 | 13,500 |
| 4. Water Lines | | | |
| a. 2" C. I. Pipe | 4,550 ft. | 3 | 13,650 |
| b. Drinking Fountains & Water Plugs | 2 | 500 | 1,000 |
| 5. Septic Tank & Field | 2 | 2,000 | 4,000 |
| 6. Electric Lines | | | |
| a. Underground Wire | 5,000 ft. | 1.25 | 6,250 |
| b. Poles, 30 ft. | 12 | 40 | 480 |
| 7. Picnic and Play Area | | | |
| a. Open Shelter | 2 | 15,000 | 30,000 |
| b. Comfort Stations | 2 | 6,000 | 12,000 |
| c. Picnic Tables | 60 | 40 | 2,400 |
| d. Grills | 30 | 30 | 900 |
| e. Concrete Base for Garbage Cans | 30 | 25 | 750 |
| 8. Bathing Beach | | | |
| a. Sanding, 300'x150, 6" deep | 833 cu.yds | 5 | 4,160 |
| b. Bathhouses | 2 | 1,500 | 3,000 |
| c. Diving Boards, Lifeguard Stand | Lump Sum | | 1,000 |
| 9. Tree Planting | Lump Sum | | 30,000 |
| 10. Grass Seeding | Lump Sum | | 9,600 |
| 11. Boating | | | |
| a. Launching Ramps | 1 Lump Sum | | 480 |
| b. Boat Docks | 1 Lump Sum | | 300 |
| 12. Signs | Lump Sum | | 2,000 |
| Total - (With P.L. 566 cost sharing) | | | $217,680 |

1/ Price Base: 1970

Date: November 1970

TABLE 3 - STRUCTURAL DATA

STRUCTURES WITH PLANNED STORAGE CAPACITY
Bacon Creek Watershed, Iowa

| Item | Unit | STRUCTURE NUMBER | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A-1 | A-1-1 | A-2 1/ | A-2-1 | A-2-2 | A-2-3 | A-2-4 | A-2-6 1/ | A-3 | B-1 |
| Class of Structure | | a | c | a | a | a | a | c | a | c | c |
| Drainage Area | Sq.Mi. | 0.21 | 0.20 | 0.14 | 0.18 | 0.50 | 0.19 | 2.22 | 0.11 | 1.10 | 0.50 |
| Uncontrolled | Sq.Mi. | 0.21 | 0.20 | 0.14 | 0.18 | 0.50 | 0.19 | 2.22 | 0.11 | 1.10 | 0.50 |
| Controlled | Sq.Mi. | - | - | - | - | - | - | 0.98 2/ | - | 0.35 2/ | - |
| Curve No. (1-day) (AMC II) | | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 |
| Tc | Hrs. | 0.15 | 0.13 | 0.10 | 0.30 | 0.33 | 0.29 | 0.80 | 0.10 | 0.59 | 0.56 |
| Elevation Top of Dam | Ft. | 1315.5 | 1191.4 | 1303.0 | 1290.0 | 1275.5 | 1283.5 | 1215.8 | 1254.0 | 1225.0 | 1180.0 |
| Elevation Crest Emergency Spillway | Ft. | 1313.0 | 1186.5 | 1301.0 | 1287.5 | 1272.5 | 1281.0 | 1208.0 | 1252.0 | 1218.0 | 1174.0 |
| Elevation Crest High Stage Inlet | Ft. | 1306.0 | 1185.0 | 1298.0 | 1280.0 | 1265.0 | 1275.0 | 1198.4 | 1249.0 | 1208.0 | 1172.0 |
| Elevation Crest Low Stage Inlet | Ft. | - | 1180.0 | - | - | - | - | - | - | - | 1166.0 |
| Maximum Height of Dam | Ft. | 60 | 36 | 51 | 57 | 54 | 49 | 47 | 30 | 67 | 37 |
| Volume of Fill | Cu.Yd. | 37,000 | 27,000 | 20,000 | 42,000 | 55,000 | 29,000 | 103,000 | 15,000 | 90,000 | 56,000 |
| Total Capacity | Ac.Ft. | 123.0 | 72.5 | 51.6 | 84.3 | 261.2 | 71.3 | 817.0 | 46.0 | 321.5 | 178.3 |
| Sediment Submerged 1st 50 years | Ac.Ft. | 21.0 | 15.0 | 9.0 | 12.0 | 108.0 | 14.1 | 131.0 | 30.0 | 83.0 | 49.0 |
| Sediment Submerged 2nd 50 years | Ac.Ft. | 66.0 | 25.0 | 31.5 | 43.7 | 52.4 | 25.9 | 97.0 | 2.0 | 72.0 | 30.0 |
| Sediment Aerated | Ac.Ft. | 7.6 | 6.0 | 3.0 | 3.0 | 27.0 | 3.0 | 41.0 | 8.0 | 27.0 | 14.0 |
| Beneficial Use - Recreation | Ac.Ft. | - | - | - | - | - | - | 157.0 | - | - | - |
| Retarding | Ac.Ft. | 28.4 | 26.5 | 8.1 | 25.6 | 73.8 | 28.3 | 391.0 | 6.0 | 139.5 | 85.3 |
| Between high and low stage | Ac.Ft. | | 19.6 | - | - | - | - | - | - | - | 51.0 |
| Surface Area | | | | | | | | | | | |
| Sediment pool | Ac. | 4.3 | 4.2 | 1.9 | 3.2 | 10.8 | 3.9 | 22.7 | 3.1 | 11.6 | 9.4 |
| Retarding pool | Ac. | 5.7 | 6.5 | 2.4 | 4.6 | 15.6 | 6.6 | 56.0 | 3.8 | 21.5 | 15.8 |
| Recreation pool | Ac. | - | - | - | - | - | - | 34.1 | | | - |
| Principal Spillway | | | | | | | | | | | |
| Rainfall Volume (areal) (1 day) | In. | 6.3 | 6.3 | 4.4 4/ | 6.3 | 6.3 | 6.3 | 6.3 | 4.4 4/ | 6.3 | 6.3 |
| Rainfall Volume (areal) (10 day) | In. | 10.2 | 10.1 | - | 10.2 | 10.2 | 10.2 | 10.2 | - | 10.1 | 10.2 |
| Runoff Volume (10 day) | In. | 4.64 | 4.56 | 1.9 4/ | 4.64 | 4.64 | 4.64 | 4.64 | 1.9 4/ | 4.56 | 4.40 |
| Capacity of Low Stage (Max.) | cfs | - | 10.0 | - | - | - | - | - | - | - | 11.3 |
| Capacity of High Stage (Max.) | cfs | 28.0 | 112.0 | 21 | 21.0 | 43.0 | 20.0 | 122.0 | 20 | 118.0 | 102.0 |
| Frequency operation - Emer.Splwy. | % chance | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| Size of Conduit | Dia.In. | 18 | 30 | 18 | 18 | 24 | 18 | 30 | 18 | 30 | 30 |
| Emergency Spillway - Type | | Veg. | Veg. | Veg. | Veg. | Veg. | Veg. | Veg. | Veg. | Veg. | Veg. |
| Rainfall Volume - (ESH) (areal) | In. | 7.3 | 10.0 | - | 7.3 | 7.3 | 7.3 | 10.0 | - | 10.0 | 10.0 |
| Runoff Volume (ESH) | In. | 4.15 | 6.59 | - | 4.15 | 4.15 | 4.15 | 6.59 | - | 6.59 | 6.65 |
| Bottom Width | Ft. | 40 | 50 | 25 | 40 | 50 | 24 | 150 | 20 | 136 | 60 |
| Velocity of Flow ($V_e$) | Ft/Sec. | 3.1 | 3.7 | - | 3.4 | 3.9 | 3.6 | 0 | - | 6.4 | 5.8 |
| Slope of Exit Channel | Ft/Ft. | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.03 | 0.04 | 0.03 | 0.05 |
| Maximum water surface elevation | Ft. | 1313.6 | 1187.3 | - | 1287.8 | 1273.3 | 1281.4 | 1208.0 | - | 1220.2 | 1175.4 |
| Freeboard | | | | | | | | | | | |
| Rainfall Volume (FH) (areal) | In. | 12.7 | 24.7 | - | 12.7 | 12.7 | 12.7 | 24.7 | - | 24.7 | 24.7 |
| Runoff Volume (FH) | In. | 9.14 | 20.77 | - | 9.14 | 9.14 | 9.14 | 20.77 | - | 20.77 | 20.83 |
| Maximum water surface elevation | Ft. | 1315.4 | 1191.4 | 1303.0 | 1290.0 | 1275.5 | 1283.5 | 1215.8 | 1254.0 | 1225.0 | 1180.0 |
| Capacity Equivalents | | | | | | | | | | | |
| Sediment Volume 3/ | In. | 7.73 | 4.31 | 5.8 | 5.8 | 7.03 | 3.96 | 4.13 | 6.9 | 3.10 | 3.47 |
| Retarding Volume | In. | 2.52 | 2.49 | 0.92 | 2.56 | 2.77 | 2.72 | 3.04 2/ | 1.03 | 2.38 2/ | 3.20 |

1/ Structure does not fall within the limiting criteria of SCS Engineering Memorandum-27; designed per SCS-Iowa criteria; surveys not available; quantities are estimated

2/ For this structure design, structures upstream were ignored in flood routing, but were credited for sediment storage.

3/ The principal spillway crest elevation was established for grade stabilization or sediment storage, whichever was greater; therefore, the storage at the crest elevation of some structures is greater than that required for sediment.

4/ 6 hr. storm used for design.

TABLE 3 - STRUCTURAL DATA (Cont.)

STRUCTURES WITH PLANNED STORAGE CAPACITY
Bacon Creek Watershed, Iowa

| Item | Unit | STRUCTURE NUMBER | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | C-1 | D-2 | H-1 | H-1-1 | H-1-3 | H-2-1 | H-2-2 | H-3-1 | H-3-2 | J-1 |
| Class of Structure | | c | c | b | b | a | a | b | b | b | a |
| Drainage Area | Sq.Mi. | 0.25 | 0.56 | 0.34 | 0.59 | 0.32 | 0.17 | 1.30 | 0.33 | 0.42 | 0.42 |
| Uncontrolled | Sq.Mi. | 0.25 | 0.56 | 0.34 | 0.27 | 0.32 | 0.17 | 0.17 2/ | 0.33 | 0.42 | 0 |
| Controlled | Sq.Mi. | - | - | - | 0.32 | - | - | - | - | - | - |
| Curve No. (1-day) (AMC II) | | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 |
| Tc | Hrs. | 0.40 | 0.66 | 0.21 | 0.21 | 0.28 | 0.19 | 0.79 | 0.24 | 0.24 | 0.45 |
| Elevation Top of Dam | Ft. | 1164.5 | 1163.0 | 1274.2 | 1170.5 | 1244.5 | 1310.5 | 1197.0 | 1302.6 | 1270.5 | 1239.0 |
| Elevation Crest Emergency Spillway | Ft. | 1159.5 | 1157,5 | 1270.5 | 1166.5 | 1241.5 | 1308.5 | 1193.0 | 1300.0 | 1267.5 | 1235.5 |
| Elevation Crest High Stage Inlet | Ft. | 1157.5 | 1156.0 | 1263.0 | 1162.0 | 1236.0 | 1305.0 | 1183.0 | 1295.0 | 1263.0 | 1228.0 |
| Elevation Crest Low Stage Inlet | Ft. | 1153.0 | 1148.5 | - | - | - | - | - | - | - | - |
| Maximum Height of Dam | Ft. | 38 | 43 | 48 | 38 | 38 | 57 | 49 | 50 | 44 | 45 |
| Volume of Fill | Cu.Yd. | 31,000 | 54,000 | 22,000 | 30,000 | 35,000 | 35,000 | 49,000 | 43,000 | 27,000 | 33,000 |
| Total Capacity | Ac.Ft. | 65.1 | 165.5 | 78.9 | 82.2 | 94.4 | 130.9 | 275.0 | 163.2 | 185.8 | 85.5 |
| Sediment Submerged 1st 50 years | Ac.Ft. | 16.0 | 41.0 | 22.0 | 21.0 | 27.0 | 15.0 | 70.0 | 28.0 | 39.0 | 18.4 |
| Sediment Submerged 2nd 50 years | Ac.Ft. | 11.5 | 23.0 | 21.6 | 33.9 | 22.0 | 93.0 | 52.0 | 91.4 | 88.0 | 13.2 |
| Sediment Aerated | Ac.Ft. | 5.0 | 11.0 | 6.8 | 7.0 | 10.0 | 4.6 | 22.8 | 8.4 | 12.5 | 10.4 |
| Beneficial Use - Recreation | Ac.Ft. | - | - | - | - | - | - | - | - | - | - |
| Retarding | Ac.Ft. | 32.6 | 90.5 | 28.5 | 20.3 | 35.4 | 18.3 | 130.2 | 35.4 | 46.3 | 43.5 |
| Between high and low stage | Ac.Ft. | 23.0 | 80.0 | - | - | - | - | - | - | - | - |
| Surface Area | | | | | | | | | | | |
| Sediment pool | Ac. | 4.2 | 8.0 | 3.6 | 5.5 | 4.4 | 5.8 | 10.2 | 7.7 | 10.6 | 4.2 |
| Retarding pool | Ac. | 7.4 | 14.9 | 5.4 | 7.4 | 9.6 | 6.9 | 21.2 | 9.8 | 13.2 | 9.6 |
| Recreation pool | Ac. | - | - | - | - | - | - | - | - | - | - |
| Principal Spillway | | | | | | | | | | | |
| Rainfall Volume (areal) (1 day) | In. | 6.3 | 6.3 | 5.7 | 5.7 | 5.7 | 5.7 | 5.7 | 5.7 | 5.7 | 5.7 |
| Rainfall Volume (areal) (10 day) | In. | 10.2 | 10.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 |
| Runoff Volume (10 day) | In. | 4.40 | 4.40 | 3.72 | 3.72 | 3.72 | 3.72 | 3.72 | 3.72 | 3.72 | 3.72 |
| Capacity of Low Stage (Max.) | cfs | 9.60 | 12.7 | - | - | - | - | - | - | - | - |
| Capacity of High Stage (Max.) | cfs | 110.0 | 117.0 | 110.0 | 98.0 | 22.0 | 20.0 | 109.0 | 75.0 | 73.0 | 36.0 |
| Frequency operation - Emer.Splwy. | % chance | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Size of Conduit | Dia.In. | 30 | 30 | 30 | 30 | 18 | 18 | 30 | 30 | 30 | 24 |
| Emergency Spillway - Type | | Veg. | Veg. | Veg. | Veg. | Veg. | Veg. | Veg. | Veg. | Veg. | Veg. |
| Rainfall Volume - (ESH) (areal) | In. | 10.0 | 10.0 | 7.3 | 7.3 | 7.3 | 7.3 | 7.3 | 7.3 | 7.3 | 7.3 |
| Runoff Volume (ESH) | In. | 6.65 | 6.65 | 4.15 | 4.15 | 4.15 | 4.15 | 4.15 | 4.15 | 4.15 | 4.15 |
| Bottom Width | Ft. | 52 | 90 | 50 | 50 | 50 | 48 | 116 | 56 | 62 | 50 |
| Velocity of Flow ($V_e$) | Ft/Sec. | 4.3 | 6.0 | 4.3 | 3.2 | 6.0 | 2.2 | 5.5 | 2.6 | 5.5 | 5.5 |
| Slope of Exit Channel | Ft/Ft. | 0.038 | 0.032 | 0.05 | 0.049 | 0.04 | 0.046 | 0.034 | 0.056 | 0.04 | 0.06 |
| Maximum water surface elevation | Ft. | 1160.6 | 1159.3 | 1271.5 | 1167.1 | 1242.5 | 1308.8 | 1194.5 | 1300.4 | 1268.3 | 1236.7 |
| Freeboard | | | | | | | | | | | |
| Rainfall Volume (FH) (areal) | In. | 24.7 | 24.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 |
| Runoff Volume (FH) | In. | 20.83 | 20.83 | 9.14 | 9.14 | 9.14 | 9.14 | 9.14 | 9.14 | 9.14 | 9.14 |
| Maximum water surface elevation | Ft. | 1164.5 | 1163.0 | 1274.2 | 1170.2 | 1244.4 | 1310.5 | 1197.0 | 1302.6 | 1270.5 | 1238.8 |
| Capacity Equivalents | | | | | | | | | | | |
| Sediment Volume 3/ | In. | 1.72 | 2.51 | 2.74 | 4.29 | 3.46 | 12.3 | 2.41 | 6.84 | 6.24 | 1.83 |
| Retarding Volume | In. | 2.44 | 3.03 | 1.56 | 1.41 | 2.08 | 2.00 | 2.17 2/ | 2.02 | 2.06 | 1.94 |

2/ For this structure design, structures upstream were ignored in flood routing, but were credited for sediment storage.
3/ The principal spillway crest elevation was established for grade stabilization or sediment storage, whichever was greater; therefore, the storage at the crest elevation of some structures is greater than that required for sediment.

TABLE 3 - STRUCTURAL DATA (Cont.)

STRUCTURES WITH PLANNED STORAGE CAPACITY
Bacon Creek Watershed, Iowa

| Item | Unit | STRUCTURE NUMBER J-2 | J-3 | J-5 1/ | K-1 1/ | L-1 | L-2 | L-3 | M-1 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Class of Structure | | a | b | a | a | a | a | a | a | |
| Drainage Area | Sq.Mi. | 0.55 | 2.61 | 0.17 | 0.21 | 0.25 | 0.69 | 0.14 | 0.57 | 15.24 |
| Uncontrolled | Sq.Mi. | 0 | 1.47 | 0.17 | 0.21 | 0.25 | 0.30 | 0.14 | 0.57 | |
| Controlled | Sq.Mi. | - | 1.14 | - | - | - | 0.39 | - | - | |
| Curve No. (1-day) (AMC II) | | 74 | 74 | 74 | 74 | 74 | 74 | 74 | 74 | |
| Tc | Hrs. | 0.66 | 1.42 | 0.20 | 0.20 | 0.28 | 0.30 | 0.17 | 0.49 | |
| Elevation Top of Dam | Ft. | 1204.0 | 1182.0 | - | - | 1221.0 | 1156.0 | 1207.5 | 1216.0 | |
| Elevation Crest Emergency Spillway | Ft. | 1200.0 | 1176.3 | - | - | 1219.0 | 1154.0 | 1205.5 | 1214.0 | |
| Elevation Crest High Stage Inlet | Ft. | 1193.0 | 1168.5 | - | - | 1210.0 | 1149.5 | 1200.0 | 1208.0 | |
| Elevation Crest Low Stage Inlet | Ft. | - | - | - | - | - | - | - | - | |
| Maximum Height of Dam | Ft. | 43 | 47 | 32 | 37 | 50 | 25 | 39 | 30 | |
| Volume of Fill | Cu.Yd. | 32,000 | 68,000 | 15,000 | 15,000 | 26,000 | 14,000 | 16,000 | 30,000 | 1,049,000 |
| Total Capacity | Ac.Ft. | 124.9 | 330.7 | 50.0 | 40.6 | 50.4 | 95.2 | 24.2 | 117.3 | 4186.5 |
| Sediment Submerged 1st 50 years | Ac.Ft. | 24.8 | 80 | 12.5 | 9.2 | 15.8 | 21.0 | 6.9 | 26.0 | 965.7 |
| Sediment Submerged 2nd 50 years | Ac.Ft. | 24.7 | 52.5 | 10.0 | 8.0 | 8.8 | 35.0 | 4.5 | 30.5 | 1069.1 |
| Sediment Aerated | Ac.Ft. | 8.9 | 30.7 | 5.5 | 3.1 | 4.9 | 6.6 | 2.3 | 5.0 | 305.1 |
| Beneficial Use - Recreation | Ac.Ft. | - | - | - | - | - | - | - | - | 157.0 |
| Retarding | Ac.Ft. | 66.5 | 167.5 | 22.0 | 20.3 | 20.9 | 32.6 | 10.5 | 55.8 | 1689.6 |
| Between high and low stage | Ac.Ft. | - | - | - | - | - | - | - | - | 173.6 |
| Surface Area | | | | | | | | | | |
| Sediment pool | Ac. | 6.8 | 16.5 | 3 | 3 | 2.4 | 7.3 | 1.4 | 7.6 | 185.9 |
| Retarding pool | Ac. | 13.5 | 29.5 | 5 | 5 | 5.2 | 10.0 | 3.1 | 12.1 | 327.8 |
| Recreation pool | Ac. | - | - | - | - | - | - | - | - | 34.1 |
| Principal Spillway | | | | | | | | | | |
| Rainfall Volume (areal) (1 day) | In. | 5.7 | 5.7 | - | - | 5.0 | 5.0 | 5.0 | 5.0 | |
| Rainfall Volume (areal) (10 day) | In. | 9.2 | 9.2 | - | - | 8.3 | 8.3 | 8.3 | 8.3 | |
| Runoff Volume (10 day) | In. | 3.72 | 3.72 | - | - | 3.06 | 3.06 | 3.06 | 3.06 | |
| Capacity of Low Stage (Max.) | cfs | - | - | - | - | - | - | - | - | |
| Capacity of High Stage (Max.) | cfs | 41.0 | 175.0 | - | - | 21.0 | 41.0 | 20.0 | 42.0 | |
| Frequency operation - Emer.Splwy. | % chance | 2 | 2 | - | - | 4 | 4 | 4 | 4 | |
| Size of Conduit | Dia.In. | 24 | 36 | 18 | 18 | 18 | 24 | 18 | 24 | |
| Emergency Spillway - Type | | Veg. | Veg. | Veg. | Veg. | Veg. | Veg. | Veg. | Veg. | |
| Rainfall Volume - (ESH) (areal) | In. | 7.3 | 7.3 | - | - | 4.8 | 4.8 | 4.8 | 4.8 | |
| Runoff Volume (ESH) | In. | 4.15 | 4.15 | - | - | 2.0 | 2.0 | 2.0 | 2.1 | |
| Bottom Width | Ft. | 50 | 100 | - | - | 34 | 32 | 34 | 34 | |
| Velocity of Flow ($V_e$) | Ft/Sec. | 4.7 | 6.4 | - | - | 0 | 0 | 0 | 0 | |
| Slope of Exit Channel | Ft/Ft. | 0.038 | 0.03 | - | - | 0.04 | 0.04 | 0.04 | 0.04 | |
| Maximum water surface elevation | Ft. | 1201.2 | 1178.3 | - | - | 1218.5 | 1153.7 | 1204.5 | 1213.0 | |
| Freeboard | | | | | | | | | | |
| Rainfall Volume (FH) (areal) | In. | 12.7 | 12.7 | - | - | 7.3 | 7.3 | 7.3 | 7.3 | |
| Runoff Volume (FH) | In. | 9.14 | 9.14 | - | - | 4.15 | 4.15 | 4.15 | 4.2 | |
| Maximum water surface elevation | Ft. | 1203.8 | 1181.5 | - | - | 1220.6 | 1156.0 | 1206.4 | 1215.8 | |
| Capacity Equivalents | | | | | | | | | | |
| Sediment Volume 3/ | In. | 1.97 | 2.08 | 3.1 | 1.82 | 2.21 | 3.95 | 1.83 | 1.99 | |
| Retarding Volume | In. | 2.27 | 2.14 | 2.4 | 1.82 | 1.57 | 2.06 | 1.41 | 1.84 | |

1/ Structure does not fall within the limiting criteria of SCS Engineering Memorandum-27; designed per SCS-Iowa criteria; surveys not available; quantities are estimated.
2/ For this structure design, structures upstream were ignored in flood routing, but were credited for sediment storage.
3/ The principal spillway crest elevation was established for grade stabilization or sediment storage, whichever was greater; therefore, the storage at the crest elevation of some structures is greater than that required for sediment.
4/ 6 hr. storm used for design.

Date: November 1970

TABLE 3B - STRUCTURAL DATA

GRADE STABILIZATION STRUCTURES

Bacon Creek Watershed, Iowa

| Site No. | Drainage Area | | Drop | Concrete | Type of Structure 1/ |
|---|---|---|---|---|---|
| | Uncontrolled: (Sq.Mi.) | Controlled (Sq.Mi.) | (Feet) | (Cu.Yds.) | |
| A-2-5 | 0.34 | 0.70 | 26 | 110 | CH |
| A-2-7 | 0.16 | 2.22 | 8 | 20 | IC |
| A-4 | 0.23 | 0.35 | 30 | 95 | CH |
| D-1 | 0.19 | - | 8 | 40 | DS |
| F-1 | 0.27 | - | 26 | 100 | CH |
| H-1-2 | 0.07 | 0.32 | 27 | - | DI |
| H-2 | 1.94 | 2.82 | 20 | 150 | DI |
| J-4 | 0.50 | 0.17 | 12 | 120 | DI |
| M-2 | 0.59 | 0.57 | 13 | 130 | DI |

1/ DS - drop spillway
CH - chute spillway
IC - inlet on culvert
DI - drop inlet

Date: November 1970

TABLE 4 - ANNUAL COSTS

Bacon Creek Watershed, Iowa

(Dollars) 1/

| Eval. Unit | Structural Measures | Amortization of Installation Cost | Operation and Maintenance | Total |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| 1 | A-1, A-1-1, A-2, A-2-1, A-2-2, A-2-3, A-2-5, A-2-6, A-2-7, A-3, A-4, A-2-4 & Basic Recreational Facilities | 49,100 | 17,990 2/ | 67,090 |
| 2 | B-1, C-1, D-1, D-2 | 9,050 | 490 | 9,540 |
| 3 | F-1 | 1,370 | 80 | 1,450 |
| 4 | H-1, H-1-1, H-1-2, H-1-3, H-2, H-2-1, H-2-2, H-3-1, H-3-2 | 17,690 3/ | 1,070 4/ | 18,760 |
| 5 | J-1, J-2, J-3, J-4, J-5 | 9,320 | 600 | 9,920 |
| 6 | K-1, L-1, L-2, L-3 | 4,730 | 400 | 5,130 |
| 7 | M-1, M-2 | 3,020 | 230 | 3,250 |
| Project Administration | | 11,820 | XX | 11,820 |
| TOTAL | | 106,100 | 20,860 | 126,960 |

1/ Price Base: Installation costs are based on 1970 price level and are amortized at 5-1/8 percent over 100 years. Operation and maintenance costs are based on adjusted normalized prices, April 1966.

2/ The amount of $15,940 for operation, maintenance and replacement costs of recreational facilities is included.

3/ Does not include the sponsors' share of construction cost of structure and land to provide for roadway.

4/ Does not include sponsors' share of O&M Cost of that portion of the structure required to provide for roadway.

Date: November 1970

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Bacon Creek Watershed, Iowa

(Dollars) 1/

| Item | Estimated Average Annual Damage | | Damage Reduction Benefit |
|---|---|---|---|
| | Without Project | With Project | |
| (1) | (2) | (3) | (4) |
| Gully Erosion 2/ | | | |
| Urban Area | 63,020 | - | 63,020 |
| Agricultural Land | 36,110 | - | 36,110 |
| Farm Crossings | 360 | - | 360 |
| Farm Fences | 330 | - | 330 |
| Utility Pipelines | 770 | - | 770 |
| Public Road Bridges | 1,230 | - | 1,230 |
| Public Roads | 1,120 | - | 1,120 |
| Subtotal | 102,940 | - | 102,940 |
| Floodwater | | | |
| Urban Area | 3,530 | - | 3,530 |
| Sediment | | | |
| Streets, Ditches, Clean-up, etc. | 20,300 | 2,030 | 18,270 |
| Indirect | 11,260 | 820 | 10,440 |
| TOTAL | 138,030 | 2,850 | 135,180 |

1/ Price Base: Adjusted normalized prices, April 1966.

2/ Damages and benefits are included for only the principal gully erosion areas which are affected by the project improvements.

Date: November 1970

## TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Bacon Creek Watershed, Iowa

(Dollars)[1/]

| Eval. Unit | Structural Measures | AVERAGE ANNUAL BENEFITS | | | | Average Annual Cost | Benefit Cost Ratio |
|---|---|---|---|---|---|---|---|
| | | Damage Reduction | Recreation Benefits | Secondary Benefits | Total | | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| 1 | A-1, A-1-1, A-2, A-2-1, A-2-2, A-2-3, A-2-5, A-2-6, A-2-7, A-3, A-4, A-2-4 & Basic Recreational Facilities | 68,640 | 87,620 | 10,380 | 166,640 | 67,090 | 2.5 to 1.0 |
| 2 | B-1, C-1, D-1, D-2 | 12,510 | - | 300 | 12,810 | 9,540 | 1.3 to 1.0 |
| 3 | F-1 | 2,010 | - | 40 | 2,050 | 1,450 | 1.4 to 1.0 |
| 4 | H-1, H-1-1, H-1-2, H-1-3, H-2, H-2-1, H-2-2, H-3-1, H-3-2 | 28,680 | - | 600 | 29,280 | 18,760 | 1.6 to 1.0 |
| 5 | J-1, J-2, J-3, J-4, J-5 | 10,210 | - | 160 | 10,370 | 9,920 | 1.1 to 1.0 |
| 6 | K-1, L-1, L-2, L-3 | 6,950 | - | 110 | 7,060 | 5,130 | 1.4 to 1.0 |
| 7 | M-1, M-2 | 5,740 | - | 80 | 5,820 | 3,250 | 1.8 to 1.0 |
| Project Administration | | XX | XX | XX | XX | 11,820 | XX |
| TOTAL | | 134,740 | 87,620 | 11,670 | 234,030[2/] | 126,960 | 1.8 to 1.0 |

1/ Price Base: Adjusted normalized price level for benefits; costs from Table 4.

2/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $440 annually.

Date: November 1970

## TABLE 7 - CONSTRUCTION UNITS

Bacon Creek Watershed, Iowa

(Dollars)[1/]

| Construction Unit | Structures | Annual Benefits | Annual Costs |
|---|---|---|---|
| 1 | A-1-1 | 5,320 | 2,130 |
| 2 | A-1, A-2, A-3, A-4 | 18,570 | 12,640 |
| 3 | A-2-1, A-2-2, A-2-3, A-2-5, A-2-6 A-2-7, A-2-4 & Basic Recreational Facilities | 142,750 | 52,320 |
| 4 | B-1, C-1, D-1, D-2 | 12,810 | 9,540 |
| 5 | F-1 | 2,050 | 1,450 |
| 6 | H-1-1, H-1-2, H-1-3 | 5,970 | 4,770 |
| 7 | H-2-1, H-2-2 | 7,750 | 5,270 |
| 8 | H-2 (H-1-1, H-1-2, H-1-3, H-2-1, H-2-2) [2/] | 16,580 | 10,960 |
| 9 | H-1 | 4,230 | 2,550 |
| 10 | H-3-1, H-3-2 | 8,470 | 5,250 |
| 11 | J-1 | 2,920 | 1,950 |
| 12 | J-2, J-3, J-4, J-5 (J-1) [2/] | 10,370 | 9,920 |
| 13 | K-1, L-1, L-2, L-3 | 7,060 | 5,130 |
| 14 | M-1, M-2 | 5,820 | 3,250 |

1/ Price Base - 1970 price level for installation costs amortized at 5-1/8 percent over 100 years; adjusted normalized prices, April 1966, for maintenance costs.

2/ Structure(s) not in parentheses are dependent upon prior or concurrent construction of those structures within parentheses.

Date: November 1970

## INVESTIGATIONS AND ANALYSES

### Land Use and Treatment Studies

An inventory of present land use was developed for the entire watershed area. This inventory included the present major classification of land use such as cropland, pasture, woodland, urban, and other uses. The land treatment measures that have been installed on cropland areas were itemized for each land capability class. This inventory was developed from information of record and from district conservationists.

A total conservation needs study was then made of the watershed area to show all of the land treatment measures that would be required to reduce soil loss from sheet erosion to permissible amounts according to technical guides for the District.

The amount of soil lost from sheet erosion under present conditions and with the planned land treatment measures installed was studied and computed for use in formulating an adequate land treatment program for watershed protection.

In consideration of the above information, Service technicians, with assistance of District Commissioners, developed a table of land use changes and land treatment measures that would be installed during the project installation period. The information was tabulated by capability classes and indicated the land use, the mechanical practices, and the crop rotations that would be installed on the cropland areas. The land treatment measures to be applied during the project installation period represents the expected accomplishments of the sponsors and farmers.

### Erosion Investigations

A field reconnaissance was made to study the type and general extent of the erosion problems that are causing damage to land and improvements in the watershed.

It was determined that sheet erosion is a problem on many of the sloping cropland areas that are still in need of land treatment. Gully erosion is very severe in many areas and is causing voiding of crop and pasturelands and depreciation of adjacent and intervening areas. Damage to roads, fences, and farm crossings from gully erosion has occurred at many places in the watershed.

Gully Erosion: Studies were made of the gully systems above all of the proposed structures in the watershed to determine the rate of land voiding by gully erosion and the rate of land depreciation which accompanies the expansion of a gully system. Depreciation is considered as a damage which occurs when land reverts to a less intensive use due to the inaccessibility of areas for normal farm

operations and the dissection of fields into small unfarmable units.

A set of 1949 (8-inch to the mile scale) aerial photos of the areas was studied and the extent of the gully erosion at that time was plotted on overlays and measured. With the aid of a set of 1966 (8-inch to a mile scale) photos the extent of the present gully erosion was field checked and recorded. These data were tabulated and computed to determine the present extent of voiding. The annual rate of voiding was obtained by dividing the difference between the voided areas, as determined above, by the number of intervening years.

Based on field observations and interviews of local farmers, these rates of growth were adjusted to provide estimates of future rates taking into consideration the amount of land treatment measures that have been recently installed and those planned to be installed; the topography and gully gradients that would be encountered in any future gully advance; soil types; the change in depths of gullies; and the drainage area remaining and susceptible to future damage.

The upper limits of the 100-year gully growth in the natural waterway was the area considered as the voided area. All voided areas were assumed to change from cropland to idle, since the hazard for livestock grazing is high and production of grass negligible. When future gully advance was limited by culverts with permanent floor elevations (not bridges), no area was considered as being voided or depreciated above this point in relation to controls below. If there was an individual gully system developing above the road culvert, the voided and depreciation evaluation was made separately from that below the road.

Based on the expected future extension of the gully system, areas were delineated on the overlays to show those areas that would depreciate to a less intensive land use in the future 100-year evaluation period. From this information the annual rate of land depreciation was calculated.

Rates of land depreciation were based on: (1) Areas of cropland isolated by gully growth would depreciate to pasture if it were not practical or economical to farm or install a crossing. This determination depended upon the size of the farm and if the need for an intensive type of operation existed. (2) Areas along gullies extending from the voided area to the lowest terrace dependent on structural measures for a stable outlet were considered as depreciating from cropland to pasture, idle or woodland as each situation dictated.

Much of the depreciated land would revert to idle or woodland due to lack of access, high fencing costs, or hazards to livestock.

The volume of gully erosion without the project and with the project was calculated for each structure drainage area. Field measurements in each drainage area were made to determine the width and depth of gullies (cross-section areas). These were multiplied by the rate of gully advance to arrive at rates of gross erosion under present conditions. It was assumed that since waterflow would be contained in the gully channels, such eroded material would be delivered as sediment to the downstream sites. The volume of sediment from gully erosion with the project installed was then calculated by considering the effectiveness of the project in reducing gully erosion and in retaining sediment in the conservation pools of the structures. These studies will be checked and revised as needed for the detailed design of the structures.

Sheet Erosion: Studies were made of the upland agricultural areas to determine the rates of sheet erosion both without and with the installation of proposed land treatment measures.

The Universal Soil Loss Equation for Predicting Soil Loss in Iowa was used to compute soil losses by sheet erosion on the basis of cover, slope length, percent of slope, soil characteristics, rainfall, and management practices. The data needed for these computations were obtained from the local SCS district conservationist, area staff, soil scientist, state technical staff, conservation plans, field inspections, and a study of soil conservation surveys. The volume of sheet erosion under existing conditions and the volume with the project installed was thus developed above each of the outlet channels being damaged by sediment and above the detention type structures included in this plan.

Sheet erosion is reduced by terracing, contour farming, crop rotations, and by other improved land management practices. Soil losses in the present terraced area have been reduced to an amount which is considered as allowable. Similar reductions will occur on the additional areas scheduled for such treatment measures in this work plan.

An estimate of the sheet erosion delivery ratio to various sites was based upon general information that has been secured in past studies. It was estimated that a range from 30 to 75 percent of the gross sheet erosion is transported to downstream sites as sediment. The losses that occur in transit are deposited on the colluvial and alluvial slopes, in the valleys, in road ditches, in outlet channels, along fence lines, and in or adjacent to waterways.

Erosion estimates and estimates of the sediment conveyed to all structure sites in the watershed were recorded on Form SCS-309. Information from this form was used by the engineer in providing for sediment storage needs in the design of the structures. These forms were also used to record data of sediment production to channels without and with the project.

Geologic Investigation

A field reconnaissance was made of the watershed to observe the geologic, physiographic, and other features of the watershed which might influence the selection of satisfactory sites and the design of structural measures. Construction experience in other watersheds with somewhat similar characteristics was useful as a guide in appraising the geological feasibility of structure sites that were selected.

All proposed structure sites were observed by the geologist and by the planning engineer. A site investigation was made at site A-2-4 using a Service operated drill rig. The foundation and borrow materials were analyzed in a soil mechanics laboratory. Based upon these findings, observations of the various sites, and previous experience at similar sites, it appears that foundation conditions are suitable and satisfactory borrow materials are available. Further site investigations, as required, will be made at other sites prior to construction. The extent and complexity of these investigations will vary from site to site and will be governed by variations in materials encountered. Sufficient funds have been included in the estimate of engineering design for this purpose.

Hydraulic and Hydrologic Investigations

These investigations were made to provide information for use in the design of the structures. In the absence of actual runoff data, runoff amounts and frequency were estimated on the basis of rainfall. Weather Bureau Technical Paper 40 was used to determine the frequency and amount of rainfall. The hydrologic runoff curve number was computed for the anticipated future land use and treatment. This curve number, which is an index of the runoff producing potential of an area as related to the local soil types, cover conditions, and land treatments, was used to estimate the runoff volumes to be considered in the design of detention type structures. The runoff volumes and time of concentration were also used, in conjunction with Iowa Technical Note Engineering No. 10 and SCS T.P. 149 to determine the peak flow requirements for full flow structures.

Economic Investigations

Gully Erosion Damage: The evaluation of gully erosion damage to land was based on the annual land losses from voiding and from depreciation to less intensive use of the adjacent fields. These annual rates, for voiding and for depreciation, were multiplied by the per acre values to find total damages that occur at each site. These per acre values represent losses that will occur in years that follow, since the damage cannot be recovered.

The land use and crop rotations considered for these evaluations were those which are within the criteria and standards of the use capabilities of the land, determined through soil surveys and land use capability classifications. The level of yields used were those obtained by farmers following a moderately high level fertility and management program and an intensity of farming operations consistent with the most intensive practical cropping pattern applicable within the area. Where associated soil and water conservation measures were necessary to make possible the above level of intensity of farming, the average annual value of the cost of these required associated measures were deducted from the total average annual benefits.

The gross income from the land affected was determined on a per acre basis as the monetary values of all the products grown on the area, e.g. field crops and pasture, times their respective normalized price per unit. These values, when combined and weighted, gave the composite per acre gross income figure for the land that would be voided and depreciated without the proposed project.

The gully damage evaluation takes account of: (1) Loss of income to farm operators during a ten-year adjustment period, (2) market value of the loss to landowners of a land resource, (3) value of the loss to local public interests of real estate tax base income, and (4) value of the loss to public interests not reflected in the market values of a land resource.

Damages without the project, with land treatment measures, and with the structural measures installed were computed.

All of the above procedures, and the methods involved, are set forth in the SCS Economics Guide, Chapter 5, "Appraisal of Sediment and Erosion Damage". Crop yield data for soils of these areas were based upon information received from Economic Research Service for the Missouri River basin report, Iowa State University, and the experience of farmers living within the watershed, and SCS technicians.

In grade stabilization problem areas, where urban development is expected to occur during the project period, agricultural benefits were computed for the number of years the land is expected to be in agriculture; urban benefits were based on the remaining years of the 100-year evaluation period.

Information was obtained from individuals who deal in urban development in regards to obtaining costs for developing the areas for housing.

The watershed that will be within the area to be used for urban use was divided into three parts in order to determine the value for urban lands. These are (1) urban use for the entire evaluation period, (2) 20 years agriculture and 80 years urban, and (3) 30 years agriculture and 70 years urban. No rates for depreciation were used in evaluating land damages in the urban area.

The average annual benefit for land damage in the urban area was determined by using the following procedure. Agricultural benefits were multiplied by the present value of an annuity of one per year at 5-1/8 percent for the number of years the land is expected to be in agriculture. Urban benefits were multiplied by the present value of an annuity of one per year at 5-1/8 percent for the number of years the land is expected to be in urban development and then discounted for the time the land was in agriculture. The figures obtained by this method would be total benefits expected to accrue during the 100-year evaluation period. Total benefits were amortized at 5-1/8 percent for 100 years to obtain average annual benefits.

Gully erosion damage to fences was obtained by field observations and farmer interviews. This information was obtained in annual feet damaged and then converted to monetary values. Physical data for farm crossing damage and road damage resulting from gully erosion were obtained by field studies. These project measures will eliminate those damages and the benefits are shown, therefore, as a project benefit.

Floodwater Damages: Floodwater damage values to the Greenville area of Sioux City or the "A" tributary were obtained by interviews by members of the Little Sioux Survey staff, members of the Area Office and State Office staff of the Soil Conservation Service. These interviews were conducted in 1958. The estimated annual floodwater damages that were based on a 25-year frequency of occurrence of this type of storm, were estimated to be $2,030. After reviewing additional interview data, it was decided to increase this amount by fifty percent or $1,000. It was felt that the initial estimate was very conservative as more homes and business establishments would now be affected by a flood. There has also been an increase in costs since the time the survey was conducted. Secondary benefits and indirect damages were added, giving a floodwater damage value of $3,030 in this tributary.

Floodwater damages on "D" tributary were obtained by interview. These are damages that occur to a furniture store, roads, channels, etc. The estimated annual damage is $500.

This gives a total urban floodwater damage of $3,530.

Sediment Damages: Sediment damages were obtained from interviews with individuals, business establishments, City street department employees, State Highway Department, and employees of the railroad of Burlington Northern, Incorporated. Estimated annual damages from sediment in Laterals A, B, C, and D are $20,300. Included in this value is clean-up of sediment from City streets, removal of sediment from road ditches along U. S. Highway 75, and cost of removal of sediment from drainage ditches by the Burlington Northern railroad. A 98 percent trap efficiency was used in determining the amount of sediment trapped behind structural measures. Considering then also the amount of uncontrolled area, a reduction in sediment was estimated to be 90 percent. Damages of $20,300 were reduced to $2,030 or a difference of $18,270 as a benefit to the project. This amount was allocated to individual structures on a percentage basis of area controlled. This was determined by using the drainage area above each structure and dividing by the total drainage area of all structures above the area evaluated for damages.

Other Damage: Preliminary investigations revealed that swamping and infertile overwash were negligible and therefore were not evaluated.

Indirect Damages: Indirect primary damages include certain losses which result from gully erosion. Some examples of such indirect damages follow. A bridge or road is damaged and traffic is forced to detour a considerable distance. Damage to fences permits livestock to escape from fields causing operators to spend considerable time to round up the strays. Also, purebred livestock may be subject to detrimental cross-breeding and a regulated feeding regimen may be interrupted.

Much valuable aftermath grazing is also lost since farmers will not utilize harvested fields because of fence damage. Farm equipment breakage resulting from crossing rilled and gullied fields is included.

Indirect benefits were estimated to be ten percent of the direct damages and were assumed to be reduced in the same proportion as the reduction in direct damages.

General: Costs incurred for installation of land treatment measures, such as land treatment waterways and structures, were considered as associated costs. Associated costs are those costs incurred which are not connected directly with the installation of the structural measures, but are necessary to realize the benefits assigned to the structural measures.

To obtain the acres of land needed for land rights, the planning engineer determined the area of land to be occupied by the structure site, spillway area, and all lands needed for sediment and floodwater storage. Monetary values were then applied to these figures to determine,by land use, the estimated sale value of land. This was the method used for structures located outside of the City limits.

Current land market values, agreed to by the Service and sponsors are cropland or pasture $400 per acre and idle areas (gullied, etc.) $50 per acre.

Cost estimates for land rights for structures and basic recreational facilities within the City limits were obtained by Mr. Ed Motz, City Appraiser for Sioux City. Values were increased 20 percent to allow for increase in value for land that may not be purchased for a few years. These values were agreed upon by Mr. Motz, the Service, and the sponsors.

All costs, except associated costs, were amortized at 5-1/8 percent, based on 100-year project life. A rate of 7 percent interest was used for associated costs.

Adjusted normalized prices were used for computing operation and maintenance costs for all benefits. Current 1970 prices were used to estimate the costs of installing all structural and land treatment measures.

Primary benefits together with secondary benefits were used in computing the benefit-cost ratios of the structural measures.

Other Benefits: Benefits due to reduced costs of future bridge replacements were evaluated by comparing costs of maintaining a road crossing both without and with project conditions.

Secondary benefits that will accrue within the immediate zone of influence of the project were considered in computing the benefits accruing to the project. Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation.

Secondary benefits are the values added over and above the immediate products or services of the project as a result of activities "stemming from" or "induced by" the project.

Secondary benefits were estimated to be ten percent of the recreation benefits and ten percent of all direct damages with the exception of damages from gully erosion.

Recreation Benefits: Benefits from the recreation use of the project works of improvement were evaluated at structure site A-2-4.

It was estimated that there would be 75,000 annual visitor days at a value of $1.50 per day. This gives a value of $112,500. This value was discounted for five years because it was estimated the pool would not fill for five years. This gives $87,620 of recreation benefits.

Engineering Design and Cost Estimates

The design of structural measures is based on applicable SCS criteria and design procedures. These include SCS National and State Engineering Handbooks, Engineering Memorandum SCS-27 and other sources of recognized engineering design material.

A stereoscopic study was made of aerial photographs and USGS topographic maps were studied to select potential sites for floodwater, sediment, and gully stabilization structures. An examination of each potential site was then made by the planning engineer and area engineer to develop definite structure proposals for these purposes. Profiles were obtained on Bacon Creek designated as tributary "A", lateral "A-1" and tributary "L". Topographic maps were developed from transit surveys for all sites with detention storage except for sites K-1 and A-2, neither of which fall under Engineering Memo SCS-27 criteria.

Other information used in selection of sites included the size of drainage area, location of overfalls, property lines, suitability of site, field access and road problems, and other information gathered by members of the planning party in regard to damages that included flood and sediment damages.

The state conservation engineer, area engineer, district conservationist, city engineer, city manager, and city council were consulted when necessary to develop agreement and understanding regarding the structure or combination of measures that would best meet the needs. Provisions are made for a minimum of 100-year sediment capacity for all detention type structures.

It is planned to use corrugated metal pipes for principal spillways for sites A-1, A-2, A-2-1, A-2-2, A-2-3, A-2-6, H-1-2, H-1-3, H-2-1, J-1, J-2, J-5, K-1, L-1, L-2, L-3 and M-1 and an estimated cost of replacing these pipes after fifty years has been incorporated in the economic evaluation. Sites L-1 and L-3 will need their principal spillway crests raised when the pipes are replaced. Extremely high fills in conjunction with foundation problems warrants the use of this type of pipe for these class "a" structures. Propped outlets will be used in structures H-1-3, J-5, L-2, and M-1. Pipes in the others will be placed high in the fills and corrugated metal pipe chutes will be used for outlets.

Structures A-1-1, A-2-4, A-3, B-1, C-1 and D-2 were all classified as "c" structures due to the Sioux City urban development downstream. Any proposed structures upstream of these were ignored in their routing so failure of any upstream structure will not endanger these "c" structures. Class "c" hydrologic criteria for the principal spillway and class "b" for the emergency and freeboard hydrographs was used in the routing of the class "a" detention structures upstream of structures A-2-4 and A-3 to give added safety to these structure systems. A-1-1, B-1, C-1 and D-2 were routed with a two stage outlet to provide for the desired release rate-- about ten percent the capacity of a 30-inch reinforced concrete pipe that is the minimum size for a "c" structure.

Structures H-1, H-1-1, H-2-2, H-3-1, H-3-2, and J-3 have been classified as "b" for design purposes because of the potential of a few isolated homes being built downstream of these locations. Structures upstream of these have also been routed using "b" hydrology. H-2-1 was routed with a class "b" storm but ignored when routing H-2-2.

The full flow grade stabilization structures were designed using an anticipated 25-year peak flow except for H-2, a cooperative road structure. An expected 50-year peak flow was utilized in the proposed design of H-2.

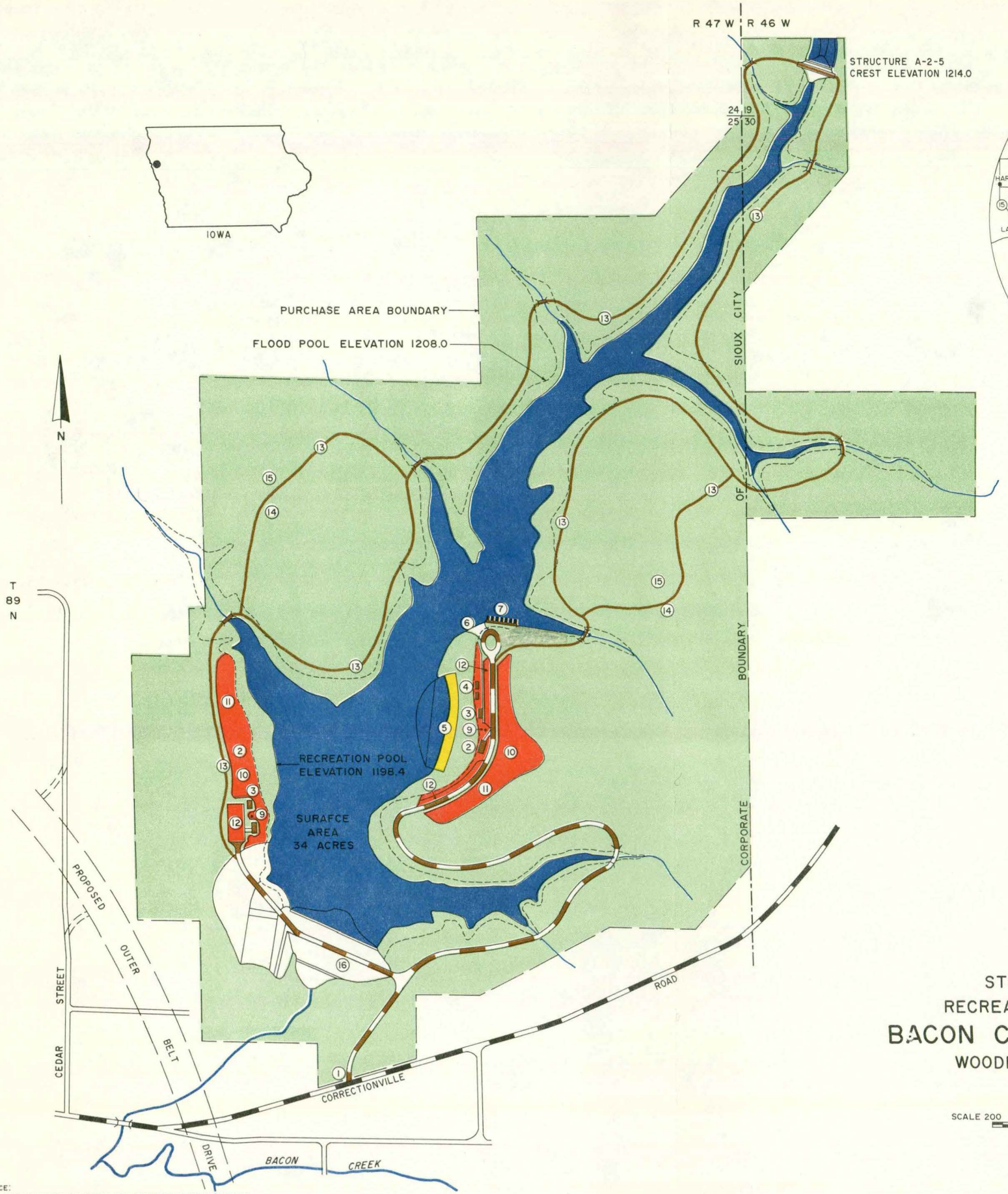
Site A-2-5, an open throat reinforced concrete chute, will be located within the recreational area and bridged so it can be part of a trail. The bridge will be a basic facility cost. Site A-4 will be a similar structure and should be designed to permit local people to bridge it also.

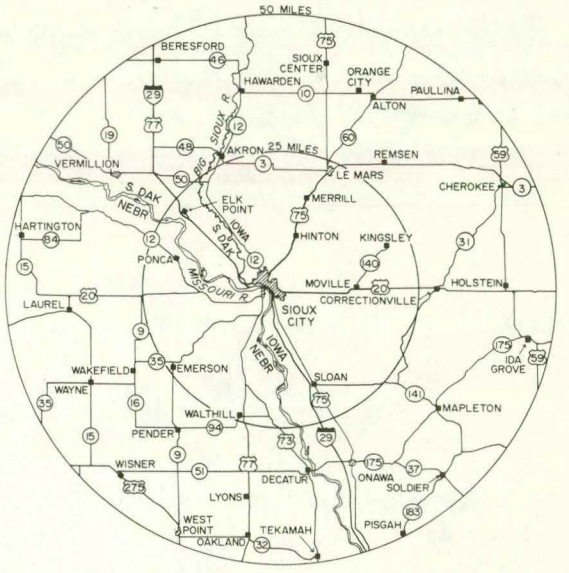
The only channel improvement proposed in the watershed is above A-2-7, the proposed concrete riser on the existing road culvert downstream of the multi-purpose site, A-2-4. This channel shaping is to add to the stability of the outlet of A-2-4 and eliminate a hazard to small children. It is proposed that all the sloping of this channel be performed from the right side and the left side (looking downstream) be left in its natural state. There will be need for some minor channel shaping downstream of some of the other structures for borrow and improving the alignment for principal spillways.

Unit prices used in developing cost estimates are a little higher than recent P.L. 566 contracts that have been awarded. It is felt that competition for recent contracts has been more than normal and higher prices can be anticipated for future contracts.

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE




POPULATION CENTERS AND HIGHWAYS
WITHIN 50 MILE RADIUS

SCALE 10 0 10 20 30 MILES

## LEGEND

1. ENTRANCE PORTAL
2. SHELTER HOUSE
3. COMFORT STATION
4. BEACH HOUSE
5. SAND BEACH
6. BOAT RAMP
7. BOAT DOCKS
8. BOAT STORAGE
9. WATER STATION
10. PICNIC AREA
11. CHILDREN'S PLAY AREA
12. PARKING AREA
13. NATURE AND HIKING TRAIL
14. OVERLOOK AND SHELTER
15. NATIVE PRAIRIE
16. STRUCTURE A-2-4

FIGURE 2

STRUCTURE A-2-4

RECREATION DEVELOPMENT

# BACON CREEK WATERSHED

WOODBURY COUNTY, IOWA

SCALE 1/7,200

SCALE 200 0 200 400 600 FEET

SOURCE:
BASE MAP PROVIDED BY SIOUXLAND INTERSTATE METROPOLITAN PLANNING COUNCIL AND DATA FURNISHED BY SCS FIELD TECHNICIANS.
ELEVATIONS ARE BASED ON U.S.C.&G.S. DATUM

USDA-SCS-LINCOLN, NEBR. 1969

12-18-69
5,S-27802

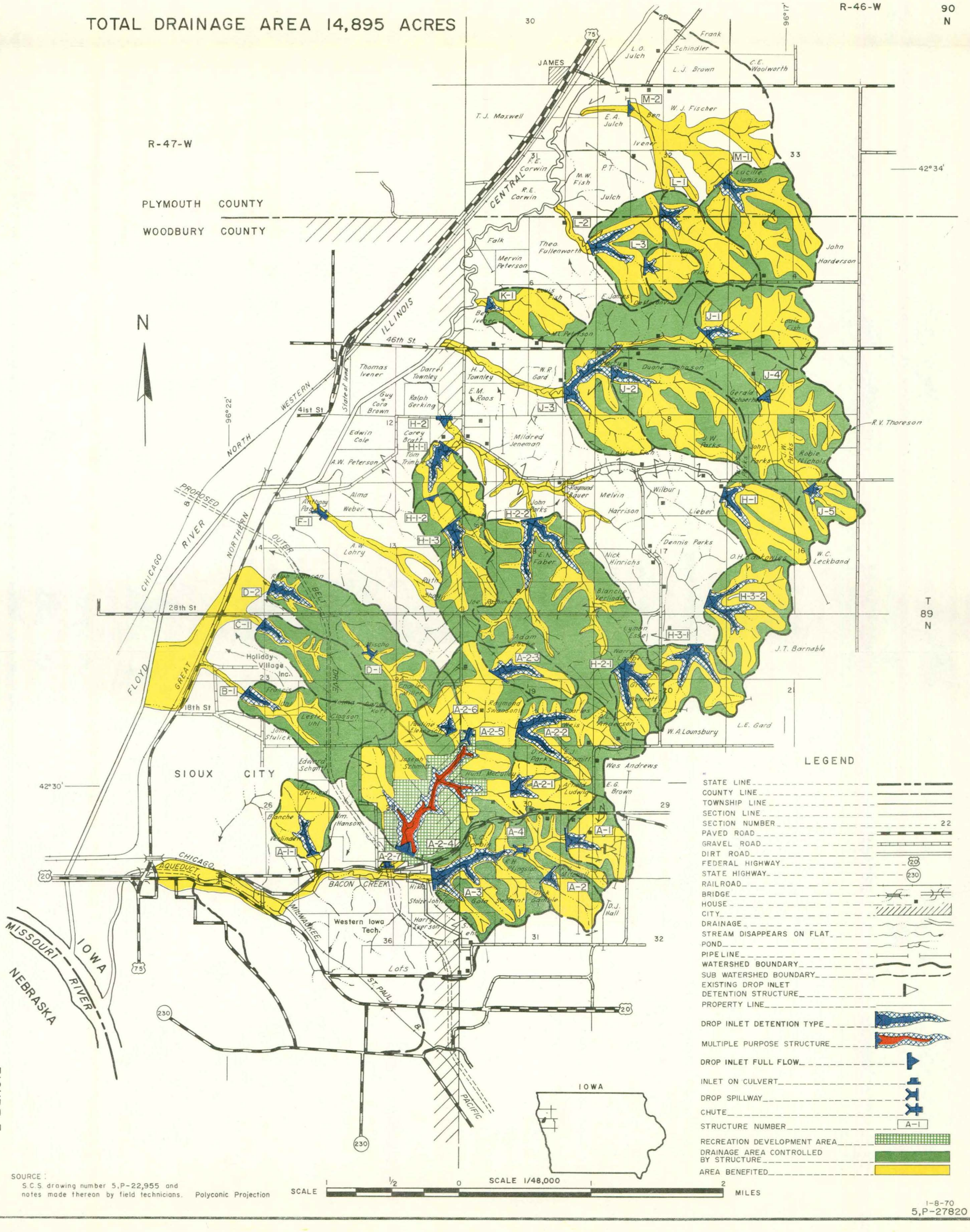
U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

# FIGURE 3
# PROJECT MAP
# BACON CREEK WATERSHED

## WOODBURY AND PLYMOUTH COUNTIES
## IOWA

## TOTAL DRAINAGE AREA 14,895 ACRES




SOURCE :
S.C.S. drawing number 5,P-22,955 and notes made thereon by field technicians. Polyconic Projection

1-8-70
5,P-27820

FIGURE 3