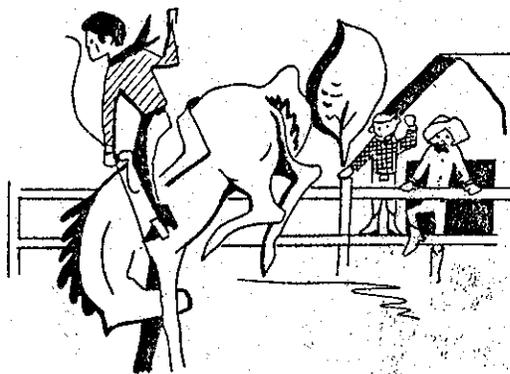


WATERSHED WORK PLAN  
**WICKENBURG WATERSHED**  
MARICOPA AND YAVAPAI COUNTIES

ARIZONA  
ADDENDUM



U.S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE

Prepared under the authority of the Watershed Protection  
& Flood Prevention Act (Public Law 566, 83rd. Congress, 68  
Stat. 666) as amended.

**DECEMBER 1974**

ADDENDUM

December 1974

WATERSHED WORK PLAN  
Wickenburg, Arizona

Maricopa and Yavapai Counties  
Arizona

## CONTENTS

Introduction

Part 1 - Discount rate comparison.

Part 2 - Display of impacts to the national economic development, environmental quality, regional development, and social well-being accounts.

Part 3 - Display of the abbreviated environmental quality alternative.

## INTRODUCTION

This addendum is based on procedures established for application of the Water Resources Council's Principles and Standards to implementation studies in process.

The Wickenburg Watershed work plan was developed using 1972 installation costs, a 5-1/2 percent discount rate, and current prices for values other than agricultural products in the evaluation of the project structural measures.

Part 1 of this addendum shows the effect of evaluating the structural measures using current installation costs and the current discount rate.

Part 2 of the addendum displays the effects of the selected plan as evaluated for each of the separate accounts — national economic development, environmental quality, regional development, and social well-being. Values for costs, prices, and rates are those of the work plan.

Part 3 of the addendum displays an abbreviated alternative plan developed to emphasize environmental quality. Bases for costs, prices, and rates are those of the work plan.

ADDENDUM  
Wickenburg Watershed, Arizona

Discount Rate Comparison

This shows the effect of evaluating the structural measures using a 5-7/8 percent discount rate, 1973 installation costs, and current prices for values other than agricultural products.

Average annual costs, benefits, and the benefit cost ratio are as follows:

1. Average annual costs are \$24,600.
2. Average annual benefits are \$37,640.
3. The benefit-cost ratio is 1.5:1.0.

SELECTED ALTERNATIVE  
 NATIONAL ECONOMIC DEVELOPMENT ACCOUNT  
 Wickenburg Watershed, Arizona

<u>Components</u>	<u>Measures of Effects <sup>1/</sup></u> - - - Dollars - - -	<u>Components</u>	<u>Measures of Effects <sup>1/</sup></u> - - - Dollars - - -
<b>Beneficial Effects:</b>		<b>Adverse Effects:</b>	
A. The value to users of increased outputs of goods and services		A. The value of resources required for a plan	
1. Flood prevention	35,570	1. Floodwater retarding structures and pipelines	
		Project installation	18,470
		Project administration	1,490
		OM&R	1,160
Total beneficial effects	35,570	Total adverse effects	21,120
		Net beneficial effects	14,450

<sup>1/</sup> Average annual effects

March 1974

Part 2-1

SELECTED ALTERNATIVE  
ENVIRONMENTAL QUALITY ACCOUNT  
Wickenburg Watershed, Arizona

Components

Measures of Effects

Components

Measures of Effects

Beneficial and Adverse Effects:

A. Areas of natural beauty

1. Reduction of floodwater and sediment damage to 110 residential properties will provide opportunities for improvement of property including homes, yards and surrounding areas.
2. Acres of land flooded by the 100-year frequency storm will be reduced from sixty-nine acres to ten acres.
3. Flood plain management and zoning will prevent increased floodwater and sediment damage. Green belts, park and open space development will be encouraged.
4. Land treatment measures will increase vegetative cover on 32,150 acres.

B. Quality consideration of water, land, and air resources

1. Sediment deposition from the watershed will be reduced by 4,300 tons annually through the land treatment measures and structural measures.
2. Erosion in the upper portion of the watershed will be reduced from 1.00 ton per acre per year to .94 ton per acre per year when land treatment measures are installed.
3. Density of ground cover will be increased by 3.5 percent when installation of land treatment measures slow the flow of floodwaters.
4. Water quality will be improved when the average suspended sediment concentration of the flow in the watershed is reduced from 20,000 mg/l to 18,600 mg/l.

SELECTED ALTERNATIVE  
 ENVIRONMENTAL QUALITY ACCOUNT (Continued)  
 Wickenburg Watershed, Arizona

<u>Components</u>	<u>Measures of Effects</u>	<u>Components</u>	<u>Measures of Effects</u>
Beneficial and Adverse Effects:			
B. Quality consideration of water, land, and air resources (Cont'd)	5. Air pollution will be increased slightly during the project construction period estimated to be one year.		3. Land treatment, seeding and brush management on range will improve wild-life food and vegetative cover on approximately 32,150 acres.
C. Biological resources and selected eco-systems	1. The 41 acres upstream from the structures will remain undeveloped and will provide islands of vegetation and open space inside the city limits of the town. This area will support small game and songbird populations.  2. Treatment of the rangeland will increase the proportion of perennial vegetation and reduce the proportion of annual vegetation.	D. Historical, archeological, and geological	4. Fifteen acres of existing habitat will be lost when the floodwater retarding structures and outlet pipelines are installed.  1. Field investigations have indicated that no areas of historical, archeological, and geological value will be affected by this project.
		E. Irreversible or irremediable commitment	1. The structural measures will commit forty-one acres of land to the construction of structural works and for the flood pool.

SELECTED ALTERNATIVE  
REGIONAL DEVELOPMENT ACCOUNT  
Wickenburg Watershed, Arizona

<u>Components</u>	<u>Measures of Effects</u> <sup>1/</sup>		<u>Components</u>	<u>Measures of Effects</u> <sup>1/</sup>	
	<u>State of</u>	<u>Rest of</u>		<u>State of</u>	<u>Rest of</u>
	<u>Arizona</u>	<u>Nation</u>		<u>Arizona</u>	<u>Nation</u>
	- - - Dollars - - -			- - - Dollars - - -	
Income:			Income:		
Beneficial Effects:			Adverse Effects:		
A. The value of increased output of goods and services to users residing in the region			A. The value of resources contributed from within the region to achieve the outputs		
1. Flood prevention	35,570	--	1. Floodwater retarding structures and pipelines		
			Project installation	3,180	15,290
			Project administration	215	1,275
			OM&R	1,160	0
Total beneficial effects	35,570	--	Total adverse effects	4,555	16,565
			Net beneficial effects	31,015	-16,565

<sup>1/</sup> Average annual effects

March 1974

Part 2.11

SELECTED ALTERNATIVE  
 REGIONAL DEVELOPMENT ACCOUNT (Continued)  
 Wickenburg Watershed, Arizona

<u>Components</u>	<u>Measures of Effects</u>		<u>Components</u>	<u>Measures of Effects</u>	
Employment:	<u>State of</u> <u>Arizona</u>	<u>Rest of</u> <u>Nation</u>	Employment:	<u>State of</u> <u>Arizona</u>	<u>Rest of</u> <u>Nation</u>
Beneficial Effects:			Adverse Effects:		
A. Increase in number and types of jobs			A. Decrease in number and types of jobs	0	0
1. Employment for project construction	11 semi-skilled jobs for 1 year	--			
2. Employment for project OM&R	0.2 permanent semi-skilled job	--			
3. Employment in service and trade activities induced by and stemming from project operation	17 semi-skilled jobs for 1 year	--			
Total beneficial effects	28 semi-skilled jobs for 1 year	--	Total adverse effects	0	0
	0.2 permanent semi-skilled job	--			
			Net beneficial effects	28 semi-skilled jobs for 1 year	0
				0.2 permanent semi-skilled job	0

Part 2-5

March 1974

SELECTED ALTERNATIVE  
 REGIONAL DEVELOPMENT ACCOUNT (Continued)  
 Wickenburg Watershed, Arizona

Components

	Measure of Effects	
State of Arizona		Rest of Nation

Regional Economic Base and Stability

Beneficial Effects:

The project will protect 110 residential properties from floodwater and sediment damage. Total value of property protected from flooding is estimated to be \$1,865,000. The project will create 28 semi-skilled jobs for one year for residents in the town of Wickenburg.

--

Flood protection is essential to this area if urban development and maintenance and improvement of present urban property is to continue.

--

Adverse Effects:

--

---

Part 2-6

March 1974

SELECTED ALTERNATIVE  
SOCIAL WELL-BEING ACCOUNT  
Wickenburg Watershed, Arizona

Components

Measures of Effects

Beneficial and Adverse Effects:

A. Real Income Distribution

1. Create 28 man-years of semi-skilled employment.
2. Create regional <sup>1/</sup>income benefit distribution of \$35,570 flood damage reduction benefits by income class as follows:

<u>Income Class</u> -- Dollars --	<u>Percentage of Adjusted Gross Income in Class</u>	<u>Percentage Benefits in Class</u>
Less than 3,000	14	23
3,000-10,000	55	64
More than 10,000	31	13

3. Local cost to be borne by region total \$4,555 with distribution by income class as follows:

<u>Income Class</u> -- Dollars --	<u>Percentage of Adjusted Gross Income in Class</u>	<u>Percentage Contributors in Class</u>
Less than 3,000	14	10
3,000-10,000	55	44
More than 10,000	31	46

B. Life, health, and safety

1. Provide protection to 110 residential properties within a sixty-nine acre urban area. Future threats of loss of life and relocation of families due to flooding will be eliminated. Reduction of flooding will eliminate threat of contamination of water supply and damage from sewage overflow and resultant health hazards.

C. Educational, cultural, and recreational

1. Reduction of flooding will allow for personal property improvements and an overall higher standard of living for residents. Expenses used for replacement and repair of flood damaged property can be used for other community purposes.

<sup>1/</sup> The realization of these flood damage reduction benefits will occur in the town of Wickenburg since the benefited area is within the town limits.

# ABBREVIATED ENVIRONMENTAL QUALITY PLAN WICKENBURG WATERSHED, ARIZONA

MARCH 1974

OBJECTIVES

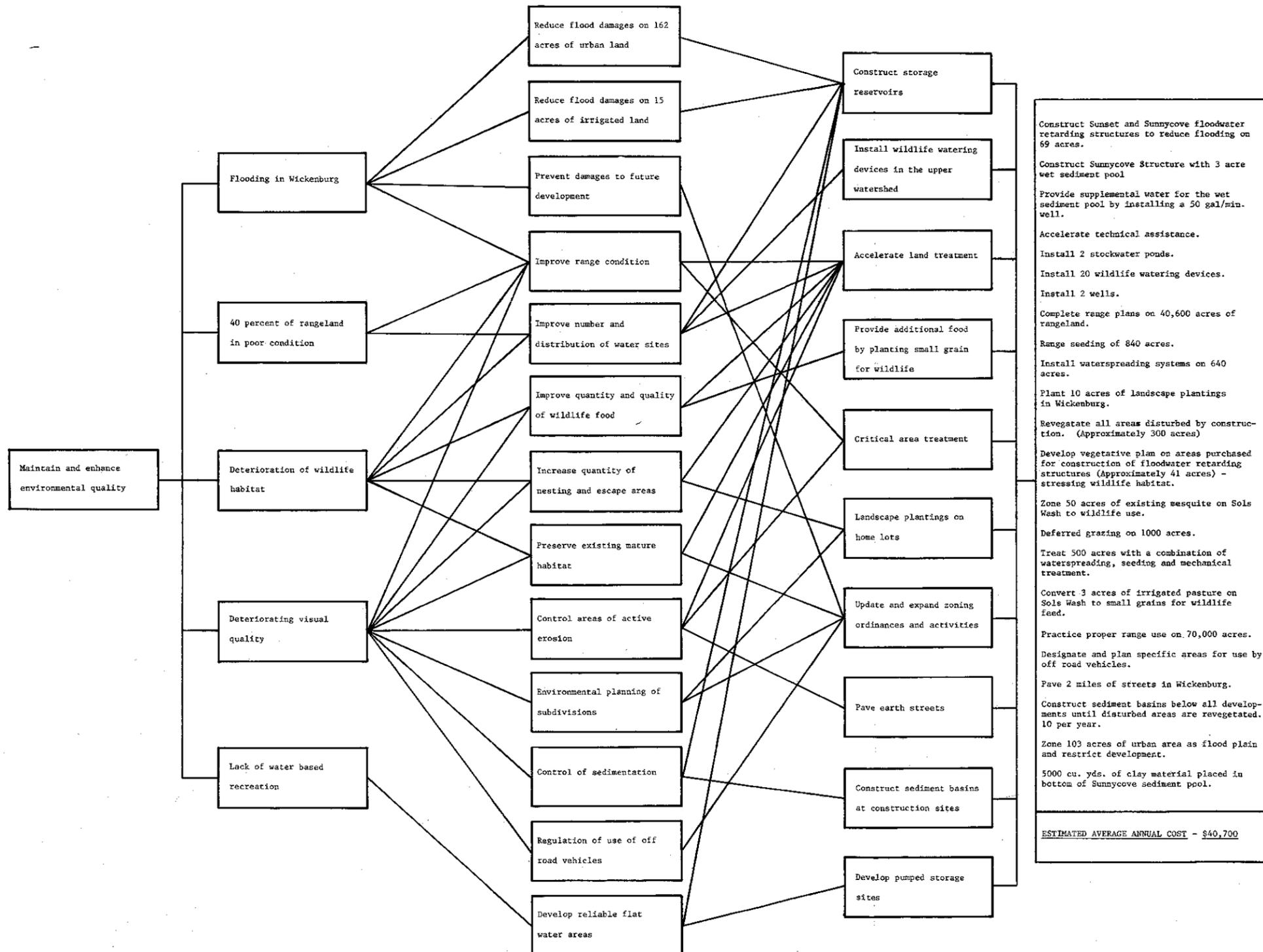
PROBLEMS

COMPONENT NEEDS

OPPORTUNITIES

PLAN ELEMENTS

ENVIRONMENTAL EFFECTS



Construct Sunset and Sunnycove floodwater retarding structures to reduce flooding on 69 acres.

Construct Sunnycove Structure with 3 acre wet sediment pool

Provide supplemental water for the wet sediment pool by installing a 50 gal/min. well.

Accelerate technical assistance.

Install 2 stockwater ponds.

Install 20 wildlife watering devices.

Install 2 wells.

Complete range plans on 40,600 acres of rangeland.

Range seeding of 840 acres.

Install waterspreading systems on 640 acres.

Plant 10 acres of landscape plantings in Wickenburg.

Revegetate all areas disturbed by construction. (Approximately 300 acres)

Develop vegetative plan on areas purchased for construction of floodwater retarding structures (Approximately 41 acres) - stressing wildlife habitat.

Zone 50 acres of existing mesquite on Sols Wash to wildlife use.

Deferred grazing on 1000 acres.

Treat 500 acres with a combination of waterspreading, seeding and mechanical treatment.

Convert 3 acres of irrigated pasture on Sols Wash to small grains for wildlife feed.

Practice proper range use on 70,000 acres.

Designate and plan specific areas for use by off road vehicles.

Pave 2 miles of streets in Wickenburg.

Construct sediment basins below all developments until disturbed areas are revegetated. 10 per year.

Zone 103 acres of urban area as flood plain and restrict development.

5000 cu. yds. of clay material placed in bottom of Sunnycove sediment pool.

**ESTIMATED AVERAGE ANNUAL COST - \$40,700**

- AREAS OF NATURAL BEAUTY**
- 1) Encourage home improvements in the urban area by reducing flood damages on 69 acres.
  - 2) Provide areas of open space and green belts in urban area by use of flood plain management program.
  - 3) Improve visual quality of the upper watershed by reducing the number and extent of raw and eroding areas.
  - 4) Provide an unnatural view from 10 homes by construction of the floodwater retarding structures.
  - 5) Provide variety in the local landscape by having a three acre permanent pool at the Sunnycove site.
  - 6) Assure an undeveloped green belt near the center of Wickenburg by preserving 50 acres of mesquite along Sols Wash.
  - 7) Provide a natural area of beauty on the south side of Wickenburg by developing vegetation on the 41 acres around the reservoirs.
  - 8) Alter the natural landscape of the rangeland in the upper watershed by constructing waterspreaders to distribute water over 1140 acres.
  - 9) Provide a sharp contrast at the damsites during and immediately following construction between the natural landscape and the construction sites.
- QUALITY CONSIDERATION OF WATER, LAND AND AIR**
- 1) Reduce the amount of sediment delivered to the Hassayampa River by about 5000 tons per year.
  - 2) Reduce sediment and debris deposition on 69 acres of urban land.
  - 3) Reduce erosion rate to acceptable levels on 500 acres of severe erosion.
  - 4) Increase air and water pollution during the four year construction period.
  - 5) Reduce the amount of dust raised by traffic in Wickenburg.
  - 6) Reduction of wind blown pollutants resulting from increased cover on the rangeland.
  - 7) Decrease the deterioration of the quality of rangeland resulting from overuse by improving the distribution of livestock and wildlife.
  - 8) Reduce scarring and erosion on rangeland and existing structures by restriction of off road vehicles.
- BIOLOGICAL RESOURCES AND SELECTED ECOLOGICAL SYSTEM**
- 1) Provide three acre pond for waterfowl resting and flat water fishery habitat at Sunnycove reservoir.
  - 2) Maintain and protect existing mesquite area in Wickenburg for wildlife habitat. (Approximately 50 acres)
  - 3) Improve wildlife food and cover vegetation through land treatment, seeding and brush management on range.
  - 4) Provide additional water for wildlife use facilitating better distribution of wildlife.
  - 5) Provide additional nesting and resting areas in town.
  - 6) Loss of existing habitat on 15 acres to construct floodwater retarding structures and outlet pipelines.
- GEOLOGICAL, ARCHEOLOGICAL AND HISTORICAL RESOURCES**
- IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS**
- 1) Commit about 41 acres of land, of which ten acres are in the existing flood plain, to the construction of the structural works and for the flood pools.
  - 2) Commit about 200 acres of rangeland to the construction of waterspreader dikes to treat 1140 acres by waterspreader systems.

WATERSHED WORK PLAN

WICKENBURG WATERSHED

Maricopa and Yavapai Counties, Arizona

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

Prepared by: Flood Control District of Maricopa County  
Triangle Natural Resource Conservation District  
Wickenburg Natural Resource Conservation District  
Yavapai County Board of Supervisors  
Town of Wickenburg

With Assistance by:

U. S. Department of Agriculture, Soil Conservation Service

December 1974

# TABLE OF CONTENTS

## Wickenburg Watershed, Arizona

	<u>Page</u>
WORK PLAN AGREEMENT	AGR-1
SUMMARY OF WORK PLAN	i
WATERSHED RESOURCES - ENVIRONMENTAL SETTING	1
Physical Data	1
Economic Data	5
Fish and Wildlife Resources	7
Recreational Resources	7
Archeological and Historic Values and Unique Scenic Area	7
Soil, Water, and Plant Management Status	8
WATER AND RELATED LAND RESOURCE PROBLEMS	9
Land Treatment	9
Floodwater and Sediment Damage	9
Sunset-Sunnycove Wash Reach	10
Casandro Wash Reach	11
Sols Wash Reach	12
Indirect Damages	13
Other Problems	13
PROJECTS OF OTHER AGENCIES	14
PROJECT FORMULATION	15
Objectives	17
Environmental Considerations	17
Alternatives	18
Sunset and Sunnycove Washes	19
Casandro Wash	20
Sols Wash	21
Selected Alternative	23
WORKS OF IMPROVEMENT TO BE INSTALLED	24
Land Treatment Measures	24
Non-Federal Land	24
Federal Land	26
Structural Measures	31
EXPLANATION OF INSTALLATION COSTS	34
Land Treatment Measures	34
Structural Measures	34
Construction	34
Engineering Services	35

	<u>Page</u>
Project Administration	35
Land Rights	35
Relocation Payments	35
Cost Sharing	36
Expected Expenditures of Funds by Fiscal Years	37
 EFFECTS OF WORKS OF IMPROVEMENT	 38
 PROJECT BENEFITS	 41
 COMPARISON OF BENEFITS AND COSTS	 41
 PROJECT INSTALLATION	 42
 FINANCING PROJECT INSTALLATION	 46
Land Treatment	46
Structural Measures	46
 PROVISIONS FOR OPERATION AND MAINTENANCE	 47
Land Treatment Measures	47
Structural Measures	48
Operation	48
Maintenance	48
 TABLES	
1 - Estimated Project Installation Cost	49
1A - Status of Watershed Works of Improvement	50
2 - Estimated Structural Cost Distribution	51
3 - Structural Data	52
3A - Structural Data	53
4 - Annual Costs	54
5 - Estimated Average Annual Flood Damage Reduction Benefits	55
6 - Comparison of Benefits and Costs for Structural Measures	56
 INVESTIGATIONS AND ANALYSES	 57
Land Use and Treatment	58
Hydrologic Investigations	59
Basic Data	59
Floodwater Retarding Structures	59
Damage-Frequency Analysis	59
Geologic Investigations	61
Sunset Wash	61
Sunnycove Wash	61
Sedimentation Investigations	63
Sunnycove Wash	63
Sunset wash	64
Engineering Investigations	65
Maps and Aerial Photographs	65
Surveys	65

	<u>Page</u>
Design Criteria	65
Alternate Studies	66
Cost Estimates	66
Economic Investigations	68
Fish and Wildlife Investigations	70

FIGURES

- Figure 1 (A) - Sunset Dam
- Figure 1 (B) - Sunset Pipeline
- Figure 1 (C) - Sunset Pipeline
- Figure 1 (D) - Sunset Pipeline
- Figure 1 (E) - Sunset Pipeline
- Figure 2 (A) - Sunnycove Dam
- Figure 2 (B) - Sunnycove Dam
- Figure 2 (C) - Sunnycove Pipeline
- Figure 2 (D) - Sunnycove Pipeline
- Figure 2 (E) - Sunnycove Pipeline
- Figure 3 - Urban Flood Plain Map
- Figure 4 - Land Status Map
- Figure 5 - Project Map

# WATERSHED WORK PLAN AGREEMENT

Between the

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

TRIANGLE NATURAL RESOURCE CONSERVATION DISTRICT

WICKENBURG NATURAL RESOURCE CONSERVATION DISTRICT

YAVAPAI COUNTY BOARD OF SUPERVISORS

TOWN OF WICKENBURG

(Hereinafter referred to as the Sponsoring Local Organization)

State of Arizona

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 Organization for assistance in preparing a plan for works of improvement for the Wickenburg Watershed, State of Arizona, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd 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 Organization and the Service a mutually satisfactory plan for works of improvement for the Wickenburg Watershed, State of Arizona, 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 Organization 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 four 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. The Flood Control District of Maricopa County will acquire, with other than P. L. 566 funds, such land rights as will be needed in connection with the works of improvement. (Estimated cost \$57,560.)
2. The Flood Control District of Maricopa County assures that comparable replacement dwellings will be available for individuals and persons displaced from dwellings and will provide relocation assistance advisory services and relocation assistance, make the relocation payments to displaced persons, and otherwise comply with the real property acquisition policies contained in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894) effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. The costs of relocation payments will be shared by the Flood Control District of Maricopa County and the Service as follows:

	Sponsoring Local <u>Organization</u> (percent)	<u>Service</u> (percent)	Estimated Relocation <u>Payment Costs</u> (dollars)
Relocation Payments	32.9	67.1	0 <sup>1/</sup>

1/ Investigation has disclosed that under present conditions the project measures will not result in the displacement of any person, business, or farm operation. However, if relocations become necessary, relocation payments will be cost-shared in accordance with the percentages shown.

3. The Flood Control District of Maricopa County 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 the works of improvement.
4. The total construction cost of the structural measures will be borne by the Service. (Estimated cost \$230,580.)
5. The cost of installing land treatment measures on 500 acres needing critical area treatment will be shared between the Service and the Triangle and Wickenburg Natural Resource Conservation Districts, with the Service paying 80 percent and the Natural Resource Conservation Districts paying 20 percent. (Estimated cost is \$48,000 and \$12,000, respectively.)

6. The total engineering services cost will be borne by the Service. (Estimated cost \$46,110.)
7. The Sponsoring Local Organization and the Service will each bear the cost of Project Administration which it incurs, estimated to be \$3,870 and \$23,060, respectively.
8. The Wickenburg Natural Resource Conservation District 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.
9. The Triangle and Wickenburg Natural Resource Conservation Districts will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.
10. The Triangle and Wickenburg Natural Resource Conservation Districts will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.
11. The Flood Control District of Maricopa County 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.
12. 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.
13. 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 availability of appropriations for this purpose. A separate agreement will be entered into between the Service and the Sponsoring Local Organization before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working agreements and other conditions that are applicable to the specific works of improvement.
14. 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 except for cause. The Service may terminate financial and other assistance in whole, or in part,

at any time whenever it is determined that the Sponsoring Local Organization has failed to comply with the conditions of this agreement. The Service shall promptly notify the Sponsoring Local Organization in writing of the determination and the reasons for the termination, together with the effective date. Payments made to the Sponsoring Local Organization or recoveries by the Service under projects terminated for cause shall be in accord with the legal rights and liabilities of the parties.

15. 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.
16. 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. 15.1-15.12), which provide that no person in the United States shall, on the grounds 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.
17. This agreement will not become effective until the Service has issued a notification of approval and authorizes assistance.

Flood Control District of Maricopa County

The signing of this agreement was authorized by a resolution of the governing body of the Flood Control District of Maricopa County adopted at a meeting held on February 3, 1975

By *Bob Stark*  
Title *Chairman*  
602 County Administration Building  
111 South Third Avenue  
Address Phoenix, Arizona 85003 Zip Code  
Date February 3, 1975

*Lee Woodell*  
(Secretary) *Clerk*  
Address Same Zip Code  
Date February 3, 1975

Triangle Natural Resource Conservation District

The signing of this agreement was authorized by a resolution of the governing body of the Triangle Natural Resource Conservation District adopted at a meeting held on Jan 30, 1975

By  Curtis D. Ritter   
Title  Chairman   
Address  Box 66  Zip Code \_\_\_\_\_  
Date  Jan 30, 1975

Calvin Stuart   
(Secretary)  
Address  Prescott 86307  Zip Code \_\_\_\_\_  
Date  Jan 30, 1975

Wickenburg Natural Resource Conservation District

The signing of this agreement was authorized by a resolution of the governing body of the Wickenburg Natural Resource Conservation District adopted at a meeting held on Jan 28, 1975

By  [Signature]   
Title  Chairman   
Address  Box 146   
 Salome, Ariz. 85348  Zip Code \_\_\_\_\_  
Date  Jan. 28, 1975

Vito Giorgio   
(Secretary)  
 P.O. Box 1109   
 Wickenburg, Ariz. 85358  Zip Code \_\_\_\_\_  
Date  Jan. 28, 1975

Yavapai County Board of Supervisors

The signing of this agreement was authorized by a resolution of the governing body of the Yavapai County Board of Supervisors adopted at a meeting held on Jan. 30, 1975

By  [Signature]   
Title  Chairman, Board of Supervisors   
 Courthouse   
Address  Prescott, Az. 86301  Zip Code \_\_\_\_\_

Lucille Johnson   
(Secretary) (Clerk)  
Address  Same  Zip Code \_\_\_\_\_  
Date  1/31/75

Town of Wickenburg

The signing of this agreement was authorized by a resolution of the governing body of the Town of Wickenburg adopted at a meeting held on January 31, 1975.

By E. Curtis Conell

Title Mayor

Kathryn Kenney  
(Secretary)

Address Box 1269  
Wickenburg, Arizona 85358

Box 1269  
Wickenburg, AZ. 85358

Date January 31, 1975

Date 1-31-75

Appropriate and careful consideration has been given to the environmental assessment prepared for this project and to the environmental aspects thereof.

Soil Conservation Service  
United States Department of Agriculture

Approved by:

George C. Marler  
State Conservationist

Feb 6, 1975  
Date

# WICKENBURG WATERSHED

## Watershed Work Plan

Maricopa and Yavapai Counties, Arizona

December 1974

### SUMMARY OF PLAN

The Wickenburg Watershed is located in west central Arizona, in Maricopa and Yavapai Counties. The watershed contains 100,000 acres and includes the towns of Wickenburg and Congress.

The sponsoring local organizations for the watershed are the Flood Control District of Maricopa County, Triangle Natural Resource Conservation District, Wickenburg Natural Resource Conservation District, Yavapai County Board of Supervisors, and the town of Wickenburg. Technical assistance in the preparation of the work plan was provided by the Soil Conservation Service of the United States Department of Agriculture. Others who provided data considered in preparation of the work plan are: The Arizona Game and Fish Department, and within the United States Department of Interior, the Bureau of Sport Fisheries and Wildlife, and the Bureau of Land Management.

The principal watershed problems are floodwater and sediment damage to residential and commercial properties in the town of Wickenburg. These damages are primarily caused by storm runoff in three local drainages, Sunset-Sunnycove Wash, Casandro Wash, and Sols Wash.

The proposed works of improvement include land treatment measures which will be installed throughout the 100,000-acre watershed and structural measures which will control the runoff from 1,250 acres of the watershed identified as Sunset-Sunnycove Wash. The structural measures will result in preventing flooding on approximately 59 acres of land now subject to flooding by the once in 100-year flood and will reduce the depth of flooding on an additional 10 acres of land located in this flood plain. It is estimated that 74 homes now subject to flooding will be protected from flooding by the project.

The proposed land treatment measures include: proper grazing use, pasture and hayland planting, pasture and hayland management, irrigation water management, waterspreading systems, and brush control. Land treatment will reduce sediment damage while increasing vegetative cover in the watershed. The land treatment will have very little effect on the size of the flood peaks during infrequent storm events. This is the only program proposed in this plan that will affect the problems on Casandro Wash and Sols Wash.

The proposed structural measures consist of constructing two floodwater retarding structures with buried pipe outlets designed to control runoff from a storm that is expected to occur once in 100 years on Sunset-Sunnycove Wash. It is estimated that the construction of the proposed programs on Sunset-Sunnycove Wash will result in reducing the average annual floodwater and sediment damages from \$37,020 to \$1,270 for this evaluation reach.

Structural works of improvement to reduce flooding on Casandro Wash and Sols Wash were investigated but could not be economically justified.

The construction of the floodwater retarding structures and buried pipe outlets will require light clearing of native vegetation on approximately 15 acres. Studies show that no endangered species of vegetation exist in the area to be disturbed. The entire disturbed area, including the earth embankments, will be revegetated following the construction. The installation of the outlet pipeline will result in minor disturbance of native vegetation since it follows the city streets for much of its route. Contractors will be required to comply with existing strict guidelines for minimizing soil erosion and water and air pollution during construction.

No archeological or historical material has been identified in areas to be disturbed. The Soil Conservation Service will keep the National Park Service advised of the progress of this project in order that archeological or historical material exposed by construction, if any, may be salvaged.

The installation period of the proposed project is four years. The total project cost of \$553,560 will be borne by Public Law 566 and other funds as shown below:

Item	Project Costs (Dollars)		Total
	P.L. 566 Funds	Other Funds	
Land Treatment Measures	\$ 71,510 <sup>1/</sup>	\$120,870	\$192,380
Structural Measures - Flood Prevention	299,750	61,430	361,180
<b>TOTAL</b>	<b>\$371,260</b>	<b>\$182,300</b>	<b>\$553,560</b>

*1/ Includes the following: technical assistance cost of \$16,000 for accelerated soil surveys in Maricopa County portion of the watershed; additional technical assistance costs for installation of accelerated land treatment program (estimated to be \$7,510); 80 percent of the cost of installing land treatment on 500 acres needing critical area treatment. (Cost estimated to be \$48,000.)*

-Summary-

Land treatment measures in the watershed will be applied and maintained by the landowners and operators of the land in the Wickenburg Natural Resource Conservation District and the Triangle Natural Resource Conservation District. The Flood Control District of Maricopa County will construct, operate, and maintain the structural works of improvement. Operation and maintenance agreements will be executed between the responsible agencies and the Soil Conservation Service prior to issuing invitations to bid. Total average annual operation and maintenance cost attributed to structural measures are estimated to be \$1,160.

The estimated average annual benefits and cost of the proposed structural measures are \$35,570 and \$21,120 respectively. The ratio of benefits to costs is 1.7:1.0.

## WATERSHED RESOURCES - ENVIRONMENTAL SETTING

### PHYSICAL DATA

Wickenburg Watershed is in west central Arizona in Maricopa and Yavapai Counties between the Vulture and Date Creek Mountains. That part of the watershed within Maricopa County is in the Wickenburg NRCB, and that part within Yavapai County is in the Triangle NRCB. The 100,000 acre watershed is within the Gila Water Resource Subregion of the Lower Colorado Region. The Lower Colorado Region includes the State of Arizona and parts of Nevada, Utah, and New Mexico. The Gila River, the largest surface water system in the Region, rises in western New Mexico and flows generally west through Arizona to the Colorado River at Yuma. The largest tributary to the Gila is the Salt River which provides water for the Region's largest population center, Phoenix, Arizona. Other principal tributaries are the San Pedro and the Santa Cruz Rivers in the south, and the Agua Fria and the Hassayampa Rivers in the north.

The physical characteristics of the Region vary from the broad open expanses of the Sonoran Desert to high rugged mountains. Within the Gila Subregion, there are the principal irrigated desert valleys of Arizona and high mountain areas offering a variety of crop-producing climates. The abundant sunshine and mild winter temperatures give rise to a large winter tourist industry. Much of this activity is concentrated around Phoenix and Tucson, Arizona, but smaller outlying communities also attract winter visitors.

Wickenburg, Arizona is nationally known as a community of beautiful weather and exciting history. It is advertised as the "Dude Ranch" capital of the world. The area was known for several spectacular gold strikes. The Vulture Mine was the fourth of the gold bonanzas to be discovered in the area and was the richest find. One of the men to share in this strike was Henry Wickenburg. Wickenburg's discovery gave rise to the birth of the town bearing his name. Wickenburg located his town on the banks of the Hassayampa River where water was available to use in mining operations. The town grew as the nearby mines prospered; but in 1890, a major flood on the Hassayampa River, primarily due to the failure of Walnut Grove Dam located 18 miles upstream, wiped out essentially all development on the flood plain. Eighty-four lives were lost. The town was gradually re-established on higher ground, primarily on the west bank of the river. The Wickenburg Watershed includes all of the drainages (in Arizona called washes) that flow through the town from the north and west.

Wickenburg, the principal town in the watershed with a population of 2,375, is located at 33°58' latitude and 112°44' longitude. The unincorporated community of Congress is located in the watershed about 16 miles north of Wickenburg. The total population of the watershed

is 2,550, with about 75 people living outside of the communities of Congress and Wickenburg. Many people living in these communities own or manage rangelands in the watershed.

The watershed can be divided into two physiographic units characterized by particular combinations or patterns of topography, soils, climate, water resources, land use, and vegetative cover. A hills unit and a plains unit exist in this watershed as shown on the Land Status Map.

The hills unit, 12.1 percent (12,140 acres) of the watershed, is primarily hills and mountains with slopes ranging from 10 percent to 75 percent. Geologically the unit consists of Quaternary basalt, Cretaceous andesite, and Precambrian granite. Dominant soils of the unit are of the Cellar Series which are shallow to rock. However, on the lower slopes of the hills and in small concave depressions, the soils may be moderately deep to deep. Surface textures are usually coarse loamy sand or sandy loam. Gravel, stones, and rock outcrops are common throughout this unit. The soils, land capability class VIIIs, generally have a severe root limitation that makes them unsuited for cultivation and restricts their use to grazing and wildlife.

The shrubs in the hills unit include palo verde, range ratany, broom snakeweed, fairy-duster, Mormon tea and palo christi. Cacti include primarily saguaro, prickly pear, and cholla. Principal grasses are desert needlegrama, bush muhly, cottontop, big galleta, perennial three-awns, and six-weeks grama. The dominant plant species are palo verde, cholla, and big galleta. The ground cover is estimated at 13 percent if annuals are included.

The plains unit makes up 87.9 percent (87,860 acres) of the watershed and is primarily alluvial fans with some low hills. Geologically, the unit consists of Quaternary gravel, sand, and silt; Quaternary-Tertiary deposits of loosely to firmly consolidated gravel, sand, and silt containing local clay and gypsum; and some interbedded basalt flows and felsic tuff beds. Soils in this unit are formed from materials washed down from higher country, and are of the Continental, Whittock, and Cave Series. They are shallow to deep, have medium to coarse textured surfaces, and in many of the broad gently sloping areas have reddish clay loam or sandy clay loam subsoils. Many also have pronounced zones of lime accumulation which locally may be firmly cemented. The younger soils on the alluvial fans and flood plains are deep, often stratified, and range in texture from coarse sand to fine sandy loam or loam throughout their depth. Slopes in the unit are usually less than 3 percent. However, on the short breaks adjacent to streams that have cut into old valley fill materials, slopes may be as great as 10 percent.

Severe erosion is occurring in many small areas throughout the plains unit. Erosion rates in these areas exceed three acre-feet per square mile per year.

-Environmental Setting-

The predominant land capability class in the plains unit is class VIIc. This classification results from climatic and root limitations. The area presently irrigated is land capability class IIs and IIIs. By supplying water, the climatic limitations of the class VIIc is altered to the point where crops can be raised on the land with some restrictions on types of plants.

The plains unit shrubs are creosote bush, mesquite, shrubby buckwheat, white bursage, and brittlebush. Cacti are the prickly pear and cholla. Grasses include fluff grass, needlegrama, bush muhly, big galleta, and six-weeks grama. The dominant plant species is creosote bush with some big galleta in the flatter bottom areas and mesquite along the washes. The ground cover is estimated to average 16 percent.

Range site inventories, covering 87,670 acres of the 93,610 acres of rangeland in the watershed, show that none of the range is in excellent condition, about 15 percent is in good condition, 45 percent is in fair condition, and about 40 percent is in poor condition. The majority of the poor condition range is located in the area designated as the range site - Loam Upland.

The watershed elevation ranges from 2,070 feet at Wickenburg to 4,500 feet above mean sea level in the Date Creek Mountains near the town of Congress. The average annual temperature at Wickenburg is 64.7° with a mean minimum of 46° and a mean maximum of 82.2°. The average growing season is 226 days.

The average annual precipitation at Wickenburg is 11 inches. Annual rainfall is usually about equally distributed between the winter months of November, December, January, and February, and the summer months of July, August, and September. Daily precipitation of over three inches has been recorded. The area is characterized by high intensity-short duration thunderstorms during the summer months. These thunderstorms normally cover less than 100 square miles, and the intensity of rainfall can exceed one inch in one hour. The winter precipitation normally comes from general rain and usually has a much lower intensity than the summer rains. Snowfall is generally limited to trace amounts.

The present land use in the watershed is 93,610 acres (93.6 percent) rangeland, 100 acres (0.1 percent) pastureland, and 6,290 acres (6.3 percent) of urban and built-up land. Included in the urban and built-up land are the airport and roads.

Known mineral resources within the Wickenburg Watershed include iron, titanium, silver, copper, gold and lead. At the present time, there are no mining operations being conducted in the watershed.

There is a potential for limited development of ground water resources within the watershed. Currently the domestic water for the

town of Wickenburg and the irrigation water for the pastureland near town are supplied by wells. In addition, several small livestock wells have been drilled in the upper watershed. Based on available data, there appears to be a potential for the development of additional wells in the plains unit capable of producing from 10 to 500 gallons per minute. Well production in the hills unit might be expected to range from 0 to 50 gallons per minute. The ground water in the area is generally suitable for municipal use with a minimum of treatment. The only surface water impoundments in the watershed are those stockwater ponds constructed by ranchers. There are no perennial streams in the watershed.

The drainage pattern in the watershed consists primarily of Sols Wash and its tributaries which include Casandro Wash. Sols Wash is a tributary to the Hassayampa River. A smaller tributary to the Hassayampa River, Sunset Wash, and its tributary Sunnycove Wash, drains the eastern part of the watershed.

Sols Wash originates in the Date Creek Mountains in the northern part of the watershed. There the wash flows in an unmodified, well defined natural channel with ephemeral flow (Type NE). <sup>1/</sup> As the wash flows south, it enters the alluvial fan of the plains unit. There the channel has at best a poorly defined channel (Type OE). <sup>1/</sup> The course of the wash changes from one period of flow to the next. The wash leaves the alluvial fan about 15 miles northwest of Wickenburg and again becomes well defined (Type NE). <sup>1/</sup> As the channel passes through Wickenburg, it has been modified by man at various locations in an attempt to prevent flooding of the developed areas (Type ME). <sup>1/</sup>

Casandro Wash originates near the Vulture Mine Road west of Wickenburg and south of U. S. Highway 60. It flows northeasterly in a well defined channel (Type NE) <sup>1/</sup> to Highway 60, where it enters Wickenburg, then into two subdivisions located above the Atchison, Topeka, and Santa Fe Railroad. In the area of the subdivisions, the channel has been modified by man (Type ME) <sup>1/</sup> to direct the flows into a constructed channel for a short distance and then down Mohave Street. The wash passes under the railroad and enters Sols Wash about 500 feet northeast of the tracts.

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<sup>1/</sup> SCS classification of the stream channels prior to any project activity.

TYPE NE - An unmodified, well defined natural channel or stream which flows only during periods of surface runoff, otherwise dry.

TYPE OE - None or practically no defined channel where flows occur only during periods of surface runoff, otherwise dry.

TYPE ME - Manmade ditch or previously modified channel where flows occur only during periods of surface runoff, otherwise dry.

-Environmental Setting-

Sunset and Sunnycove Washes originate southwest of Wickenburg. Sunset Wash has its origin near the Vulture Mine Road two miles southwest of Wickenburg. It flows northeast through a small tract of homes in a well defined natural channel (Type NE) until it reaches the Sunset Drive area. Here the channel has been moved to one side of the valley by man to allow the construction of homes (Type ME). After the channel passes the homes, it flows down a street to its junction with Sunnycove Wash. Sunnycove Wash originates in the foothills of the Vulture Mountains three miles southwest of its junction with Sunset Wash. The channel in these upper reaches is a well defined natural channel (Type NE). Below the confluence of Sunset and Sunnycove Washes the channel has been modified by man (Type ME) as homes were built on the flood plain. The modified channel from the confluence to where the wash enters the Fisher and Maguire Addition subdivisions is well defined but has quite limited capacity.

In the subdivision the channel is the paved Sylvan Street until it reaches the AT&SF Railroad. Between the railroad and the Hassayampa River a channel has been constructed and diked to reduce flood damages to the agricultural land in the Hassayampa River flood plain.

The quality of surface waters in the watershed has not been classified by the Arizona Health Department. It is estimated that the runoff carried by these ephemeral washes contains from 350 to 700 mg/l dissolved solids, composed primarily of calcium and magnesium carbonate-bicarbonate, with an average suspended sediment concentration of about 20,000 mg/l.

No wetlands are located in the watershed.

#### ECONOMIC DATA

The land ownership within the Wickenburg Watershed is as follows: private land, 25,665 acres; state land, 70,335 acres; and federal lands, 4,000 acres. Local public land, included in the private land figures, includes a city park in Wickenburg and the Wickenburg Municipal Airport.

There are five farms and fifteen ranches in the watershed. The farms are family-owned-and-operated with an average size of 20 acres. The farmers all have employment off the farm to supplement their income. Most of this farmland is located on the Hassayampa River flood plain. The land currently is used as pastureland to produce supplemental feed for cattle and horses. The ranches are primarily involved in beef production. The average size of the ranches is 7,100 acres, although 5 ranches or portions of ranches cover 74,000 acres. The average number of cattle grazing on the rangeland at any specific time is 1,100 head. Three of the ranches are also considered dude ranches. These ranches attract winter visitors to the Wickenburg area with goods and services provided by the town. It is estimated that these ranches can

-Environmental Setting-

accommodate 150 guests at a time. Only one of the working ranches and two of the dude ranches employ one and one-half man years or more of outside labor.

The private land in the upper reaches of the watershed ranges in value from \$350 per acre to \$800 per acre. The land on which the dude ranches is located has the higher per acre value. Land values in and near Wickenburg range from \$1,000 to \$1,500 per acre for land in the flood plain and \$2,000 to \$2,500 per acre for the upland areas. The urban property values vary considerably by location. The homes along Casandro Wash range in value from \$8,000 to \$16,000, while the homes along Sunset Drive range in value from \$15,000 to \$25,000. Homes below the confluence of Sunset and Sunnycove Washes vary in value from \$8,000 to \$80,000 with the average value in this reach being \$20,000.

Transportation facilities within the watershed are good. Access to markets is excellent because of the close proximity to the Phoenix metropolitan area. Limited railroad facilities in Wickenburg include service to and from California, Phoenix, and northern Arizona. Private and chartered air flights can be accommodated from the Wickenburg Municipal Airport.

Wickenburg has a population of 2,375 within the watershed boundary, and 25 percent of this total is over 65 years of age. This percentage of people over 65 is 2 to 3 times greater than other communities in Maricopa County. Factors that cause the high proportion of people in the over 65 age group include: (1) Wickenburg is popular as a retirement community; (2) Many of the people from the area in the under 25 age group are enrolled in colleges elsewhere, or they are in the armed forces; and (3) A high proportion of the young people are required to migrate to other communities because of the lack of job opportunities in the Wickenburg area.

Presently, tourism, cattle ranching, and agriculture are the main economic activities, although an industrial park is being developed to encourage manufacturing enterprises to locate in the town. The estimated labor force in Wickenburg is 950; and unemployment is similar to that for Maricopa County, averaging 4 percent.

Supplemental income is necessary for those persons farming within the watershed because of the small acreages. Other sources of income include employment in retail establishments and tourist facilities.

That part of the watershed within Maricopa County is within the Hohokam Resource Conservation and Development project area. That part of the watershed within Yavapai County is within the Cocopai Resource Conservation and Development project area.

## FISH AND WILDLIFE RESOURCES

Casandro and Sunset-Sunnycove Washes provide good permanent habitat for resident populations of small mammals and birds. Gambel quail, mourning and white-winged dove, and non-game birds, along with jack and cottontail rabbits, ground squirrels and other small mammals provide a limited but easily accessible wildlife resource for hunting and observation.

Sols Wash is somewhat less accessible, but because of its larger area (approximately 20 times as large as the other three washes combined), it contains a more significant wildlife resource. The habitat is in poorer condition than Casandro and Sunset-Sunnycove Washes, due to intensive grazing. The species of wildlife are the same as those found on the other washes in the watershed, except that some deer are found in the upper drainages of this wash.

Several species of reptiles and amphibians including western spadefoot toad, leopard frog, desert tortoise, zebra-tailed lizard, collared lizard, red racer, coachwhip snake, and western diamondback rattlesnake are found in the watershed. No fish are located in the watershed, and no rare or endangered species of wildlife have been identified in the watershed.

## RECREATIONAL RESOURCES

The existing recreational resources in the watershed include a city park, swimming pool, and nine-hole golf course in Wickenburg, and several dude ranches which provide opportunities for horseback riding, nature trail hikes, and other recreational facilities. The watershed does not contain any water-based recreation developments. The nearest water-based recreation area is Lake Pleasant, located approximately 50 miles east of Wickenburg. The Alamo Dam recreation area is located approximately 70 miles west of Wickenburg.

## ARCHEOLOGICAL AND HISTORIC VALUES AND UNIQUE SCENIC AREA

Although history plays an important part in the tourist industry, there are no historical sites in the watershed that are listed in the National Register of Historic Places. Field investigations by the Arizona Game and Fish Department and the Bureau of Sport Fisheries and Wildlife did not indicate any unique scenic areas of value for scientific investigations in the watershed.

The Prescott College Archeological Survey conducted an archeological survey for the project area. During the entire course of the survey, no surficial indications of archeological sites were discovered. Examination of the banks of both washes indicated no subsurface sites either. The report states: *"The Wickenburg area is not well-known archaeologically; but, based on this limited survey, it would be reasonable to assume that either (1) it was not an area of intensive prehistoric or historic*

*aboriginal occupation; or (2) any remains of aboriginal occupation have since been eroded away. The Prescott College Archaeological Survey wishes to reserve the right for future inspection of any archaeological materials discovered during construction. With this qualification, archaeological clearance for the Sunnycove-Sunset Dam Sites and the pipeline right-of-way is granted."*

The Secretary of The Interior will be notified if evidence of impacts on archeological resources is discovered during construction.

#### SOIL, WATER, AND PLANT MANAGEMENT STATUS

Very little change in land use has occurred in the watershed during the last 10 years. The urban population has increased about 10 percent with the additional land needed to provide living space for these people being less than 50 acres. Much of this new development has taken place in the foot hills of Sunset Wash, Sunnycove Wash, and Casandro Wash drainages. People are buying 2-to-5 acre lots and building \$20,000 to \$50,000 homes on them to be used as retirement or winter homes. Most of these homes are located on knolls or small hills and are not in a flood plain. Access roads are primarily graded dirt roads and are susceptible to erosion and flood damage.

Eighteen of the twenty operators within the watershed are cooperators with either the Triangle or Wickenburg Natural Resource Conservation Districts and are managing eighty-eight percent of the watershed.

The land treatment installed in the last 10 years has consisted of various measures and practices as shown in Table 1A with the total investment amount to \$194,000. These investments included \$94,000, or 100 percent of the estimated cost of the measures for livestock water in the basic conservation plans. Other investments to improve the rangeland with management practices such as proper grazing use and deferred grazing, and cultural treatment such as range seeding and fencing have totaled \$37,000 or 93 percent of the estimated cost of these rangeland measures and practices described in the basic conservation plans. The pastureland investments have totaled \$63,000 or 74 percent of the cost of measures included in the basic conservation plans. It is estimated that 29,500 acres of the watershed are adequately treated at the present time.

Past funding levels of the Rural Environmental Assistance Program of ASCS were such that most of the ranchers and farmers in the watershed were getting a maximum of 50 percent cost sharing for the installation of conservation practices. The maximum amount of assistance per year per individual has been limited to about \$2,000. In an attempt to properly distribute their livestock over the range, most of the ranchers have stressed the livestock water availability more than the erosion problem in their expenditures for land treatment in the past 10 years.

## WATER AND RELATED LAND RESOURCE PROBLEMS

### LAND TREATMENT

A major portion of the watershed is in either poor or fair range condition. Because of the severe desert climatic conditions, the area is dominated by xeric plants and supports few perennial grasses and forbs. Heavy use of the range by livestock has further reduced the amount of vegetation.

Changes in vegetation types and amounts have been characterized by a reduction of perennial grasses and desirable shrubs and an increase in annual grasses and unpalatable shrubs, such as creosote bush. These vegetative changes have increased the already large amount of bare soil subject to accelerated erosion processes. Many areas of the watershed have critical sheet and gully erosion problems.

Improved management of the land and vegetation with mechanical treatment in many areas is necessary to improve cover conditions. Economic return per acre on these lands is low. Most of the ranchers cannot afford to spend large sums of money to treat the land.

The irrigated pastureland along the Hassayampa River is subject to flooding by both the Hassayampa River and the washes in the watershed. Most of these lands have not been treated intensively enough to assure the maximum production possible with efficient use of water, due to the flood hazard.

### FLOODWATER AND SEDIMENT DAMAGE

Floodwater damage occurs frequently in the watershed. During periods of intense rainfall, primarily summer thunderstorms, sediment-laden floodwaters rush down the washes. When the flows exceed the limited capacities of the channels, overland flooding occurs.

Agricultural flood damage occurs at many locations on the rangeland and to most of the irrigated farmland in the watershed. It is estimated that 15 acres of the 100 acres of pastureland in the watershed are susceptible to flooding by the washes in the watershed, and 90 acres, including most of the 15 acres mentioned above, are subject to flooding by the Hassayampa River.

Urban and built-up areas in the Town of Wickenburg subject to flooding by the washes in the watershed amount to 162 acres with about 10 acres of this land also being subject to flooding by the Hassayampa River.

It is estimated that overland flooding occurs on the Sunset-Sunnycove Wash and Casandro Wash areas once every four years and on Sols Wash about once every 10 years.

#### Sunset-Sunnycove Wash Reach

The 100-year flood plain in the Sunset-Sunnycove evaluation reach includes 69 acres of land. A breakdown of the land susceptible to flooding shows 37 acres of developed urban land, 10 acres of irrigated pastureland, 8 acres of channels, and 14 acres of undeveloped urban land of which 4 acres are projected for future housing. All of this land is inside the city limits of Wickenburg. The existing Sunset Wash channel, built along Sunset Drive through three blocks of urban development above Sunnycove junction, will handle the once in 10-year flood without overflowing its banks. Between the confluence of these two washes and Sylvan Street, the channel will carry the once in 5-year flood without overflowing its banks. Where Sylvan Street acts as the channel, the street will carry the once in 4-year flow without overflowing and damaging lawns or houses.

During heavy rainstorms, residents in the flood plain often find the streets impassable because of the flowing water. Street erosion and sediment deposition further restrict traffic after the flood has passed. Annual street damage is normal. Damage also occurs to utility lines and sewer lines, creating hazardous health conditions.

Seven floods have occurred during the last 20 years. Houses have been flooded, yards inundated, and streets damaged. The last flood which put water inside houses occurred in September 1965. This flood event was estimated to be a once in 4-year event. Recent major flooding has been limited. The storm of August 5, 1955, estimated to be a once in 5-year storm, put water one foot deep inside two houses. Since that time, several houses have been built in the flood plain which would be flooded by a recurrence of this event.

It is projected that the once in 100-year flood (one percent event) would cause approximately \$195,000 of floodwater damages in this reach. Floodwater would inundate approximately 75 of the 110 homes on the flood plain to depths varying from 6 to 25 inches. The foundations and yards would be damaged, as well as the furniture, rugs, draperies, and household appliances. The other 35 homes in the flood plain would not have water inside them, but water would be over the yards and around the foundations of the homes. The streets and roads of the area would be damaged by the floodwater. The average annual floodwater damages on the flood plain is estimated to be \$23,720.

The damages caused by the sediment carried by the 100-year flood are projected to be \$65,000. Sediment carried by the flood flows will cause some damages to every place flooded. It will stain draperies

and rugs inside houses, be deposited in the yards and streets, and create expenses for the people trying to remove these deposits after the flood. The average annual sediment yield for the watershed is estimated to be 0.3 acre-feet, or about 600 tons of sediment per year. It is estimated that the average annual sediment damage is \$8,760.

Sediment also causes problems downstream because it adds to the amount of sediment going down the Hassayampa River. Most of the sediment drops out in the Hassayampa River channel, increasing the future flood hazard because of the loss of capacity in the river.

#### Casandro Wash Reach

The 100-year flood plain in the Casandro Wash reach includes 27 acres of land. The 27 acres include 15 acres of developed urban land 9 acres of undeveloped urban land with 5 of these acres projected for future development, and 3 acres of channels. All of this land is inside the city limits of Wickenburg. It is estimated that channel and streets through this reach can carry the once in 4-year event without flooding homes.

The open land area immediately upstream from the railroad is subject to flooding once every three years on the average because of the ponding created by the limited capacity of the railroad culvert.

During heavy rainstorms, the residents of this area have the same problems as the residents of the Sunset-Sunnycove reach in that the streets act as channels and are impassable during the runoff period. The streets in the Casandro reach are not paved in most locations, so street erosion damage is a very common problem. Every flow does some damage to the streets.

Since 1949, nine flood flows have occurred in the Casandro Wash reach. Water and sewer lines have been broken, streets have been damaged, and yards have been flooded.

It is projected that the once in 100-year flood would cause an estimated \$26,000 floodwater damage to this flood plain. Floodwater would be inside 22 of the 33 homes in the flood plain to depths varying from 1 inch to 29 inches. The foundations and contents of these houses, as well as the yards around the homes, would be damaged.

The other 11 homes in the flood plain will have water around them, but not inside the houses. The streets in the area would be damaged by the floodwater. The average annual floodwater damages are estimated to be \$2,600.

The sediment carried by the 100-year flood flow will cause an estimated \$9,000 damage to the flood plain area. This includes the

sediment damage to houses, contents of houses, yards, streets, and utilities. The average annual sediment yield from the Casandro Wash watershed is estimated to be 0.25 acre feet, or 500 tons per year. It is estimated that the average annual sediment damage to the evaluation reach is \$1,400. This sediment will contribute to the same problems downstream as described for the Sunset-Sunnycove reach.

#### Sols Wash Reach

The 100-year flood plain in this evaluation reach includes 86 acres of land. These 86 acres include 39 acres of developed urban land, 28 acres of open land, 14 acres of channels, and 5 acres of irrigated pastureland. All of this land is inside the city limits of Wickenburg. It is estimated that the present channel will handle the once in 10-year flood without overland flooding.

Every flow down the wash modifies the channel bottom and does some streambank erosion.

The flood of August 17, 1971, estimated to be a once in 25-year event, overtopped the north bank of the wash just downstream from the Highway 89 bridge and flooded approximately 15 acres of land. The land flooded included the city park, houses, and yards. Four houses were damaged and several yards were damaged by sediment deposition. The total damage caused by the flood was estimated to be \$6,200.

It is projected that the 100-year flood would cause an estimated \$67,000 of floodwater damages to the Sols Wash flood plain. Floodwater would be inside approximately 32 of the 45 houses in the flood plain to depths varying from 3 inches to 13 inches. It also would put water around the rest of the 45 houses and approximately 40 trailer houses located in the flood plain. The average annual floodwater damages are estimated to be \$3,000.

Again, on this wash as with the others, each flow will carry large volumes of sediment with the sediment causing damages. It is estimated that the 100-year flood would cause \$29,000 of sediment related damages in the evaluation reach. The average annual sediment yield of the Sols Wash drainage is estimated to be 30 acre feet, or 58,800 tons of sediment per year. The average annual sediment damages in the evaluation reach are estimated to be \$1,500. The type of damage caused downstream by this sediment is the same as described earlier in the Sunset-Sunnycove reach, but the magnitude of damages would be considerably higher because Sols Wash delivers approximately 100 times as much sediment to the Hassayampa River as that delivered by the Sunset-Sunnycove Wash.

## INDIRECT DAMAGES

Other damages caused by flooding in addition to floodwater damages and sediment damages are included as indirect damages. These indirect damages include the cost of emergency flood prevention measures, loss of production time, and expense of temporary relocation because of the need to clean up living quarters after flooding.

Emergency flood prevention measures include the patrol of potential flood hazard areas, the providing of assistance to residents of the area being flooded, and the rescuing of stranded motorists and vehicles. The loss of production time is created because of the inconvenience caused residents in traveling to and from homes to businesses. The temporary relocation costs include the costs of residents moving into motels, apartments, or other temporary homes until their homes are cleaned up and repaired.

Average annual indirect damages for the three evaluation reaches in the watershed are estimated to be: Sunset-Sunycove, \$4,540; Sols Wash, \$510, and Casandro Wash, \$420.

## OTHER PROBLEMS

Water-based recreation located closer than 50 miles to Wickenburg is desired by the residents of Wickenburg, but the erratic streamflow, because of the climatic characteristics of the area, prevents the development of water-based recreation areas in this watershed.

## PROJECTS OF OTHER AGENCIES

The Army Corps of Engineers and the Flood Control District of Maricopa County have conducted flood plain and flood control studies in and around Wickenburg. The Corps of Engineers flood plain information study for Wickenburg is found in the report titled "*Flood Plain Information Study for Maricopa County, Volume IV, Wickenburg Report, December 1965.*" Maricopa County's flood control study for Wickenburg is found in their "*Comprehensive Flood Control Program Report.*" The Bureau of Reclamation made an extensive study of the Box Canyon site on the Hassayampa River for the purpose of constructing a dam for storage of irrigation water. "*Project Planning Report 3-8 B1-2,*" dated February 1948, indicates that the frequency of flows makes the project infeasible.

The Army Corps of Engineers recently completed a second flood plain study for a six-mile reach on the Hassayampa River near Wickenburg. The study was completed in May 1972, and titled "*Flood Plain Information, Hassayampa River, Vicinity of Wickenburg, Arizona.*"

No projects have been planned by other agencies which would have any direct relationship upon the works of improvement included in this work plan.

## PROJECT FORMULATION

There has been an awareness in Wickenburg of the need for flood protection since early pioneer days. The town has actively sought solutions to its flood problems through several avenues. The Town Council has supported studies by the Army Corps of Engineers and the Bureau of Reclamation on the Hassayampa River in hopes that the construction of a dam at the Box Canyon site would reduce flooding of the town. These efforts were coupled with efforts to zone areas subject to flooding so as to reduce future damages. The Army Corps of Engineers flood plain information studies were requested to gather information to facilitate zoning.

Chapter 15, F District, Flood Plain, of the Wickenburg Zoning and Subdivision Regulations of 1972, defines the flood plain zones which have been established in Wickenburg. Section 11-15-1 states, *"This District comprises areas situated within the designated floodways. In general, the District limits follow established limits of floods of fifty (50) year frequency, within which special regulations are necessary for minimum protection of the public health and safety, and of property and improvements from hazards and damages resulting from floodwaters."* The designated floodways are, for the most part, those identified for the fifty (50) year flood plain in the Army Corps of Engineers flood information studies.

The Arizona Flood Plain Management Act of 1973 became a part of the Arizona Revised Statute 45-2342 on August 8, 1973. This act, passage of which was supported by the Town of Wickenburg, requires local governments to designate flood plains within their areas of jurisdiction and regulate development within them. Flood plain regulations adopted under the Act must, among other things, include regulation of subdivisions and other developments in the designated flood plain and regulation of minimum flood protection elevations and flood damage prevention requirements for structures and facilities which are vulnerable to flood damage. The regulations are to require that any dwelling built within a flood plain shall be constructed so as to place the minimum floor elevation of the dwelling above the high water line of the one hundred (100) year flood.

The town of Wickenburg plans to revise their zoning regulations to incorporate the intent and requirements of the Arizona Flood Plain Management Act and has by letter requested the assistance of the Arizona Water Commission.

Measures included in this plan are supplemental and complimentary to on-going flood plain management activities of the town of Wickenburg.

Residents of Wickenburg pay a one cent local sales tax to raise funds for flood protection. The "*Maricopa County, Arizona, Comprehensive Flood Control Program Report*" prepared by the Flood Control District of Maricopa County in 1963, following a series of public meetings, recommended floodwater storage structures on Sols Wash, Casandro Wash, Sunset Wash, and Sunnycove Wash. Interest in the projects was high but funds were not available either at the local or county level.

Representatives of the town council of Wickenburg attended a Wickenburg Soil Conservation District meeting in October 1967 and requested information concerning P. L. 566 and the applicability of this program to the solution of their problems. The town representatives stated that Wickenburg could not expect a very high priority for the limited funds of the County Flood Control District because of the town's small population and rural nature. They, therefore, wanted to know about the possibility of federal assistance through the P. L. 566 program.

As a result of that meeting, a tour of the watershed was conducted in April 1968 with representatives of the town of Wickenburg, Wickenburg Soil Conservation District, Triangle Soil Conservation District 1/, Yavapai County, Flood Control District of Maricopa County, and SCS in attendance. A meeting followed the tour, and it was agreed that an application for assistance under P. L. 566 would be submitted. Each of the public agencies on the tour agreed to be sponsors of the project.

A public meeting was held in Wickenburg on June 3, 1968, and local people were encouraged to define the problems of the area and assist in defining the objectives to be included in the application for assistance. The application was completed in September 1968 and was approved by Governor Jack Williams on October 9, 1968.

Following a preliminary investigation study by the SCS, a meeting was held with the sponsors on February 13, 1970, at the town hall of Wickenburg. The results of the preliminary investigation were presented. In addition to representatives from the sponsoring organization, representatives from the Wickenburg Chamber of Commerce, a local business, and professional women's club attended. The Town Council of Wickenburg endorsed the preliminary investigation report and voted to provide \$48,000 of city funds to assist in the cost of preparing a work plan.

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1/ The name of Soil Conservation Districts in Arizona was changed to Natural Resource Conservation Districts during the 1971-72 legislative year.

During the planning stage, two formal meetings were held and several other local contacts were made to report on the progress of planning and any changes in formulation since the previous meetings. Representatives of Arizona Game and Fish Department and Bureau of Sport Fisheries and Wildlife <sup>1/</sup> toured the watershed during the summer of 1971. During the formal meeting on October 6, 1971, the Wickenburg Natural Resource Conservation District requested that waterspreaders be included as a part of the proposed land treatment program.

A public meeting, announced on the local radio station and in the local paper, was held on October 28, 1971, which presented the final formulation of the project, along with the estimated total P. L. 566 and local costs involved.

As part of the comprehensive framework study for the Lower Colorado Region, an upstream flood prevention program was formulated. Treatment of the Wickenburg Watershed was included in the recommended program needed by 1980. Consequently, implementing this plan is in close harmony with findings of the Type I study.

## OBJECTIVES

In preparing the application for assistance, the sponsors identified several objectives. A primary objective was to implement the Maricopa County Flood Control District Program for Wickenburg so as to provide protection to the developed areas from the 100-year storm. The sponsors sought to reduce erosion on the watershed so as to reduce sediment damages in town and downstream. It was recognized that a comprehensive program of land treatment measures and structural measures would be needed. To the extent possible, the sponsors sought to combine water-based recreation with flood control.

## ENVIRONMENTAL CONSIDERATIONS

The effects of building structural works of improvement to reduce floodwater and sediment damages to the developed urban areas and the agricultural lands along the Hassayampa River were evaluated for Sunset Wash, Sunnycove Wash, Casandro Wash, and Sols Wash to determine the final formulation of the project.

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<sup>1/</sup> Effective July 1, 1974, the Bureau of Sport Fisheries and Wildlife becomes the U. S. Fish and Wildlife Service.

The floodwater retarding sites used in the project analysis were carefully selected. Good storage sites are not common in the watershed, but where possible, preference was given to those located in the areas of lowest value wildlife habitat and the least visual impact on the residents of Wickenburg. Channel modification was considered only when protection could not be provided by installation of floodwater retarding structures. In analyzing the channel modification alternative, construction procedures calling for removal of vegetation from one bank were used.

Both buried pipe outlets and open-lined channels were investigated during plan formulation. Preference was given to buried pipelines so as to provide the least possible long term effect on the human and wildlife environment of the flood plain. To the extent possible, alignment for the buried pipe outlets was made to follow existing streets or open areas so as to limit the amount of natural vegetation damaged.

The lack of dependable runoff above the structure sites precludes storage of a permanent pool of water in the floodwater retarding structures. Alternative floodwater retarding structures were evaluated based on the assumption that they would empty after each storm. This provides assurance that the detention capacity would be available for subsequent storms and would prevent the development of stagnant water and the resulting mosquito problem. Costs for carefully shaping borrow areas for proper drainage were included in all cost estimates.

Each alternative investigated included a plan for vegetating the dams and borrow pits so as to speed recovery of the area. Each alternative included plans for dust suppression during construction.

Land treatment measures that would reduce erosion and subsequently reduce sediment deposition in the lower reaches of the watersheds were given priority during development of the land treatment program on the upper watershed. Measures that detain or spread available water were given preference as they improve the vegetation. The improved vegetation provides better wildlife habitat as well as improved grazing for livestock. Those management practices leading to proper range use were selected for inclusion in project analysis.

## ALTERNATIVES

Several alternatives and possibilities for achieving the sponsors' objectives were considered during the formulation of a project. The following discussion identifies the studies undertaken in each of the major drainages within the watershed.

Sunset and Sunnycove Washes

Alternatives considered on these washes included: building earthfill floodwater retarding dams on both washes; building an earth dam on either of the washes; constructing an enlarged flood channel; and floodproofing of existing developments supplemented by flood plain insurance.

The building of a floodwater retarding structure on each wash would protect the homes in the urban area downstream during the once in 100-year flood. Several site locations for each of these earth dams were considered. The objective was to locate the least costly site which would provide maximum protection. Two different methods of delivering the temporarily stored water to the Hassayampa River were considered. One method included a lined open channel and the other a buried pipeline.

An earthfill dam on just Sunset Wash would provide protection to the Oxbow Drive area from the 100-year flood, but would not provide 100-year protection to the area below the junction with Sunnycove Wash.

The same is true with just the Sunnycove Dam. It would only provide 100-year protection for the area above the junction with Sunset Wash. The area below the junction would still be subject to flooding during the 100-year storm.

The construction of an enlarged flood channel would require the relocation of at least three homes and would involve the lowering of Sylvan Street. The channel above Sylvan Street would need to be stabilized by the use of either a lined channel or a series of drop structures. This alternative would provide 100-year protection to the existing buildings. Traffic on Sylvan Street would still be interrupted during each flow. Bridges would be needed at six crossings.

The effect of on-going flood plain zoning activities as well as the potential for floodproofing was studied. Flood plain zoning will prevent future damages from increasing but would not greatly reduce damages presently occurring. Buildings presently flooded would still be subject to flooding and damage. Zoning will restrict future development on the flood plain to developments that are compatible with periodic flooding. Because most of the flood plain is already built-up, zoning along Sunset-Sunnycove Wash will have limited effect. Flood insurance would reduce the financial impact of a major flood on residents in the flood plain. Floodproofing measures could be installed to reduce damages to existing homes and buildings. These measures could include, among other things, watertight doors and watertight walls.

Casandro Wash

Three possible solutions were considered which would reduce floodwater and sediment damages along Casandro Wash. These were: the construction of an earthfill floodwater retarding dam; enlarging the existing channel and the culvert under the railroad; and floodproofing of existing developments supplemented by flood plain insurance. All of the structural possibilities were found to be infeasible.

A 40-foot high earthfill dam on Casandro Wash 1,500 feet upstream from Mariposa Street was considered. This dam would control the runoff from the 100-year storm in such a manner as to prevent the flooding of existing houses on the flood plain. Mohave Street would still be subject to minor flood damage from runoff originating below the dam. The open land near the AT&SF Railroad would be available for future development. The threat to the railroad from the 100-year flood would be removed.

The construction cost of this alternative was estimated to be \$206,000. The average annual cost is \$15,000, and the average annual benefits were estimated to be \$4,400.

The enlargement of the existing channel and the railroad culvert to carry the 100-year runoff was considered. This alternative would involve the reshaping and enlarging of the existing channel for about 1,000 feet upstream from Mohave Street, the lowering and paving of Mohave Street, and the enlarging of the culvert under the railroad. This alternative would protect the developments from the 100-year flood. Travel on Mohave Street would be interrupted during each storm. The open area above the railroad track could be used for future urban development.

The estimated construction cost of this alternative is \$500,000. The average annual cost was \$33,000 with the average annual benefits estimated to be \$4,400.

Flood plain zoning established for the area shown as subject to flooding on Figure 3 will prevent the floodwater and sediment damages from increasing. New development in that area will be required to include necessary floodproofing in any construction plans. Development in the flood-prone area, including the open area above the railroad, will be regulated and priority will be given to those uses that are most compatible with the flood conditions. Such uses would include a park, open space, and green belts. Flood plain zoning will not reduce the damages to existing developments. Flood insurance would greatly reduce the financial impact of a major flood on the residents in this study area.

Floodproofing of existing buildings could be used to provide some protection from the more frequent events. Floodproofing measures would include, but are not limited to, construction of watertight walls along the major streets, particularly Mohave Street, or around individual houses and installation of watertight doors on the buildings. The intensity of investigations did not permit the completion of floodproofing cost estimates.

#### Sols Wash

Several possibilities were considered on Sols Wash to meet the sponsors' objectives. These included: construction of the multiple purpose Matthie Dam; construction of a single purpose floodwater retarding dam on Sols Wash; two channel modification alternatives; flood prevention by land treatment measures alone; a flood prevention dam on Flying E Wash; and floodproofing supplemented by flood insurance. Each structural alternative was found to be infeasible.

Construction of an earthfill dam on the Matthie site would provide both flood protection and a recreation pool. The dam would be located on Sols Wash about 6 miles west of Wickenburg and would control the runoff from 125 of the 150 square mile drainage area. The dam was originally proposed in 1963 by Johannessen and Girand, consulting engineers, and would contain 500 surface acres of water for recreational use. Construction of the dam would require the relocation of about two miles of the AT&SF Railroad. The dam would provide protection from the 100-year flood to the urban area on Sols Wash. The water supply from this ephemeral stream is very unreliable and is not adequate to maintain a quality recreational pool. Average annual costs allocated to flood prevention exceed the average annual flood prevention benefits.

A single purpose flood protection dam across Sols Wash was considered. The site investigated was downstream from the Matthie site and approximately 5 miles upstream from the Hassayampa River. It would provide the 100-year flood protection to the urban area. This site would require the relocation of two miles of the AT&SF Railroad. On an average annual basis, the costs exceeded the benefits associated with this alternative.

The construction of either of two floodwater channels was considered. One possibility consisted of the improvement of only that portion of the channel downstream from the Highway 89 bridge to the Hassayampa River. This would consist of enlarging the channel and building a dike on the north side of the channel along the park. The sides of the channel would be protected by rock riprap and sheet piling. This would protect the urban area downstream from Highway 89 from the 100-year flood but would not provide protection to the area upstream from the bridge. The average annual cost of this alternative was estimated at \$8,000 and the average annual benefits were \$4,400.

The second channel possibility consisted of enlarging and clearing the existing channel from 3,000 feet upstream of the Highway 89 bridge to the Hassayampa River. The enlarged channel would prevent floodwater damage to the buildings and park in the Sols Wash flood plain. The areas of the stream bank subject to erosion damage would be protected by rock riprap. The channel construction would remove vegetation that has been identified as valuable for dove nesting. The average annual benefits of this alternative were estimated to be \$4,900, while the costs would be greater than the \$8,000 determined for the other channel alternate.

The possibility of reducing floodwater and sediment damages on Sols Wash by the installation of land treatment measures was considered. These measures included the construction of 66,000 feet of waterspreading structures coupled with proper range use, deferred grazing, range seeding, and brush control. These measures would reduce the peak flows in Wickenburg from the 100-year storm by six percent, which is not enough to prevent flood damages. The reduction of damages in town would not justify the allocation of the construction costs for the measures to the flood prevention purpose. On-site and other off-site benefits achieved by land treatment measures warrant inclusion of those measures discussed under *"Works of Improvement to Be Installed, Land Treatment"* in the work plan.

A floodwater retarding structure on Flying E Wash approximately 1,500 feet upstream from Highway 60 was investigated. This structure would protect the Wickenburg Country Club Golf Course from flooding and would reduce the peak flows on Sols Wash through town. Construction of the dam could not be justified by the benefits realized.

The effect of flood plain zoning on the reduction of future damages was considered. The zoning of the land subject to flooding for uses other than development would reduce the damages that could occur in the future without the zoning. The existing buildings on the flood plain would still be subject to damage.

Floodproofing measures could be installed by individual property owners and/or the town. These would include, but are not limited to, the installation of watertight doors on those homes that can withstand the forces of water that would occur during the 100-year flood, and construction of watertight walls and dikes around individual homes and buildings or groups of homes and buildings. Some existing structures or mobile homes would need to be moved from the flood plain to prevent damage. Flood plain insurance could be used to relieve the burden of flood damages to those in the flood prone areas.

This alternative would not reduce damages to the city park and would limit the amount and type of development permitted on about 69 acres within Wickenburg. Estimates of the cost of floodproofing were not developed as a part of planning studies.

Selected Alternative

The following project measures have been selected for inclusion in this plan. The features of each measure are discussed under "*Works of Improvement to Be Installed.*"

An accelerated land treatment program is planned for the entire watershed. In addition, 500 acres in the Sols Wash drainage that have been designated as critical erosion and sediment source areas will receive intensive treatment.

Earthfill floodwater retarding structures will be installed on Sunset Wash and Sunnycove Wash. Floodwaters from each structure will be released into buried pipelines and carried to the Hassayampa River.

Floodwater retarding structures were selected by the sponsors from among the various alternatives which proved to be economically feasible as the most satisfactory means of providing flood protection. The structures will provide a very high level of protection while at the same time creating a minimum amount of personal inconvenience. The selected alternative will have a minor adverse impact on the human environment.

Pipeline outlets were selected because they represent the least costly alternative when considering the 100-year project life and minimize the impact on the area below the floodwater retarding structures. Releases from the structures must go through residential sections where part of the old channel has been converted to streets. Use of the existing channel system would result in long-duration flows in unstable channels.

On Casandro and Sols Washes, none of the structural alternatives studied provide adequate benefits to justify the costs. Solution of flood problems in these areas is dependent on full implementation of the Arizona Flood Plain Management Act supplemented by floodproofing and the flood insurance programs.

## WORKS OF IMPROVEMENT TO BE INSTALLED

### LAND TREATMENT MEASURES

The land treatment program outlined in this work plan will meet the sponsors' objective of reducing erosion on the watershed so as to reduce on-site damages and damages occurring in town and further downstream. Planned measures will improve cover conditions in the upper watershed and will enhance the overall quality of the range. The treatment program is based on the soil, present range condition, climate, and economic capabilities of the landowners and operators. The treatment consists of vegetative measures, management practices, and small structural works.

#### Non-Federal Land

The land treatment on the privately-owned and state-leased lands in the watershed will be accomplished through conservation plans developed for each operating unit. During the preparation of conservation plans on state-leased lands, the Arizona Game and Fish Department should be contacted for advice, especially when brush control is included in the plan. Practices included in this work plan and to be incorporated into individual conservation plans include:

Proper Grazing Use - grazing at an intensity which will maintain enough cover to protect the soil and maintain or improve the quantity and quality of desirable vegetation.

Deferred Grazing - postponing grazing or resting grazing land for a prescribed period.

Pasture and Hayland Management - proper treatment and use of pastureland or hayland.

Other practices which are not on an annual basis include:

Range Seeding - establishing adapted plants by seeding on range-land.

Brush Control - killing, suppressing or managing brush by root plowing. The area to be treated is on 0.5 to 1.5 percent slopes. The primary brush to be removed is small mesquite trees. The areas cleared that do not have sufficient grasses, forbs, and shrubs to naturally revegetate the area, will be revegetated through the range seeding

-Improvements to Be Installed-

practice. Sufficient trees and shrubs will be left in a pattern that will provide the necessary habitat for wildlife species present. 1/

Grazing Land Mechanical Treatment - renovating, contour furrowing, pitting, or chiseling native grazing land by mechanical means.

Waterspreading - diverting runoff from natural channels or gullies by means of a system of dams, dikes, or ditches, and spreading it over relatively flat areas. These earthfill structures will average less than 5 feet in height and will be between 500 and 2,000 feet in length, with pipes through the dikes. The pipes will provide water for existing vegetation located downstream. 2/

Other land treatment measures include irrigation water management, pasture and hayland planting, planned grazing system, stock ponds, and wells. These practices and measures are based on present and projected land use.

If future land use differs appreciably from that expected, alternative treatment practices and measures will be incorporated into the conservation plans and installed.

Conservation plans are being prepared or will be prepared on 40,600 acres of rangeland in the watershed. These plans combined with the existing plans will result in 78 percent of the watershed being under conservation plan.

About 500 acres of land throughout the plains unit in the Sols Wash drainage will receive intensive treatment. This critical area treatment will consist of construction of waterspreading systems, range seeding, and grazing land mechanical treatment. The specific sites to be treated will be identified and agreed upon during the development of conservation plans with landowners responsible for the management of each of the four operating units in the Sols Wash drainage.

The total planned land treatment program will add 32,250 acres of the watershed to the category of land adequately treated during the project installation period. This land, along with the land already adequately treated, will result in 61,750 acres or 62 percent of the watershed being adequately treated. Installation of land treatment measures and practices will continue under the going program of the Triangle and Wickenburg Natural Resource Conservation Districts after

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1/ It is estimated that the maximum area to be treated during the project installation period will be 1,000 acres.

2/ It is estimated that the maximum area to be treated by waterspreading systems will be 1,100 acres.

the project installation period. This work is consistent with the long range goal of each district to adequately treat all lands within their respective districts.

A low intensity soil survey has been completed on all lands in the watershed except for the 32,000 acres of land located in Maricopa County. These 32,000 acres will be surveyed during the project installation period.

#### Federal Lands

The Bureau of Land Management and permittees will continue cooperative agreements for the land treatment program on the 4,000 acres of the watershed that the Bureau of Land Management administers. Individual management plans will continue to be developed for the allotments involved.



The severe erosion mars the landscape in the upper reaches of Sols Wash

SCS Photos



Vegetation Without Waterspreader



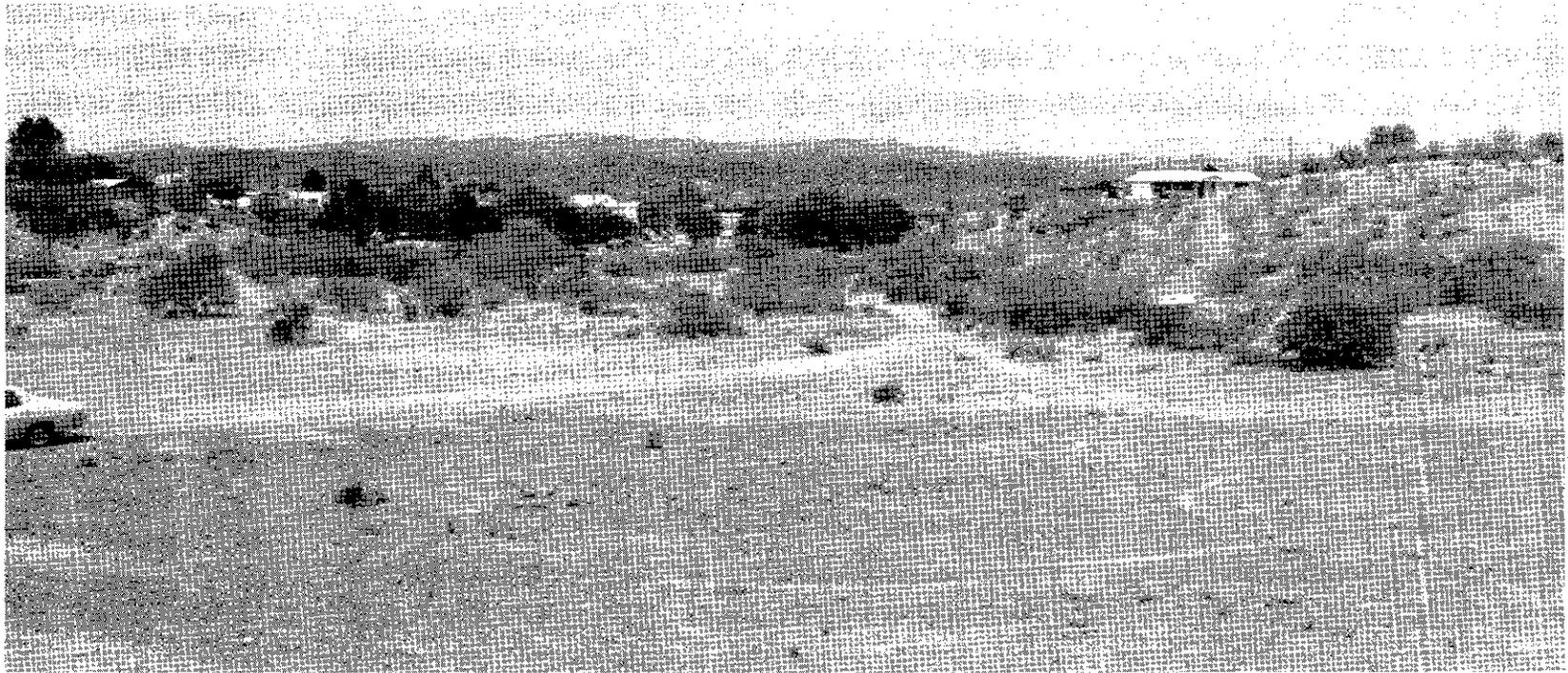
Vegetation Above Waterspreader



Water flows from left to right into the waterspreader.

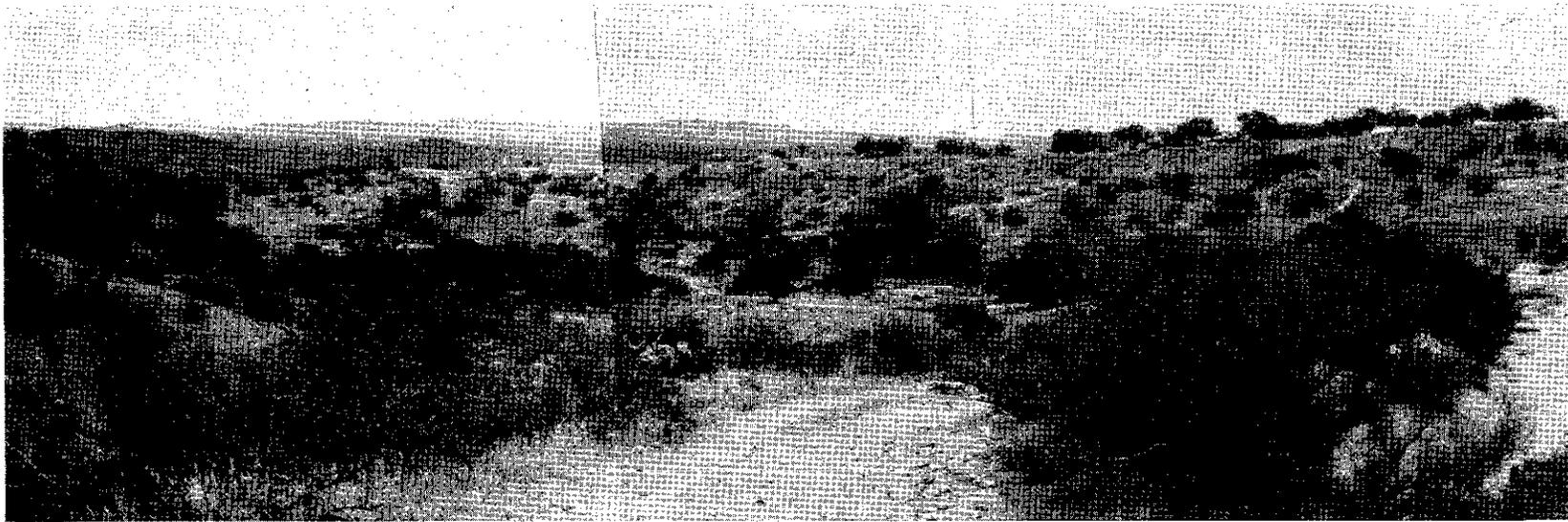
Waterspreaders have changed and increased the natural vegetation in an area near the Wickenburg Watershed.

-Improvements to Be Installed-



The Sunset Floodwater Retarding Structure will be built where the Sunset Wash narrows above developments.

SCS Photos



SCS Photos

The Sunnycove Floodwater Retarding Structure will be adjacent to the town cemetery located in the upper right-hand corner of the photo. The 750-foot long dam will be southeast of the town of Wickenburg. Wickenburg is tucked away behind the hills on the left.

## STRUCTURAL MEASURES

The proposed structural measures will include two floodwater retarding structures and principal spillway outlet pipelines. The outlet pipelines from the two structures will join together in a common pipeline to carry water to the Hassayampa flood plain. The two structures are designed to control the runoff from their respective watersheds, from a storm occurring on the average of once every 100 years (one percent chance of occurrence storm). Both structures will have dry sediment pools.

Both structures will have restricted outlets in the principal spillways. The small watersheds contributing to the structures allow low release rates that can be conveyed in pipelines to the Hassayampa River flood plain. The Sunset Dam will release an average flow of 4.4 cfs for a period of 7.6 days to evacuate the 100-year runoff volume. The Sunnycove Dam will release an average of 4.8 cfs for a period of 17 days to release the 100-year runoff volume.

The low release rates will be accomplished by a special design of the intake structures and trash rack during final design. The design used will include an ungated orifice in the wall of each intake structure. Because orifices are subject to plugging by debris, provisions will be made in the riser design to allow access to the orifice openings for cleaning. Gated openings will also be provided in each intake structure so that the reservoir can be drained in the event the orifices are plugged.

To assure proper functioning and safety of the structures, the crest of each principal spillway riser was set above the maximum water surface attained by routing the 100-year storm through the orifice in each structure. The top of the riser is open to provide an unrestricted opening below the crest of the emergency spillway. The 100-year storm was also routed through each structure for a plugged orifice condition. The crest of the emergency spillway - elevation 2,173.0 feet M.S.L. at the Sunnycove site and elevation 2,131.0 feet M.S.L. at the Sunset site - was set above the maximum water surface attained with the plugged orifice condition.

The Sunset Dam will be constructed with a 40 foot wide concrete emergency spillway chute and SAF basin. <sup>1/</sup> The spillway is located over the center of the dam so that the rare events would discharge back into the wash at the same location where they would normally flow.

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<sup>1/</sup> St. Anthony Falls (SAF) discharge stilling basin at the outlet of the concrete chute.

-Improvements to Be Installed-

The emergency spillway for the Sunnycove Dam will be excavated into the left abutment. The material is very erosion-resistant cemented conglomerate. The dam foundation will be stripped about 1-1/2 feet to the cemented material. A cutoff trench will be excavated into the conglomerate to provide protection from seepage under the embankment.

The Sunset Dam foundation will be of silt, sand, and gravel four to six feet thick overlying caliche. A cutoff core will be constructed to provide a near positive cutoff into the caliche.

The abutments on both dams are composed of materials similar to the foundation materials, and cutoff will extend into the abutments.

Both dams are single-purpose flood control structures. The sediment pools will both be drained after each storm by the low-stage ports in the principal spillway risers.

Clearing and grubbing of the small amounts of vegetation at the locations of the embankments and borrow areas will remove any organic matter present.

Borrow material for the cutoff trench and embankment fill on the Sunset site will be excavated in the reservoir area immediately upstream from the dam. Borrow material for the cutoff trench and embankment on the Sunnycove site will come from excavation in the emergency spillway and from the channel banks both upstream and downstream of the dam. The area to be disturbed upstream will be in the reservoir area. The area to be disturbed downstream will be within 1,500 feet of the dam. An alternate borrow area was also located about three-fourths mile upstream from the Sunnycove damsite, just above the elevation of the 100-year flood pool. All borrow areas will be revegetated and shaped such that they will drain and not form localized impoundments.

The construction of Sunset Dam will control the runoff from 0.6 square mile, and the construction of the Sunnycove Dam will control the runoff from 1.35 square miles, and will result in controlling 80 percent of the runoff from the 2.42 square miles drainage area of Sunset-Sunnycove Wash above the Hassayampa River.

The construction of the Sunset Dam will require the acquisition of 16 acres of land for the floodwater and sediment pool and the detention dam with spillway. Currently about 4 acres of this land is in the 100-year flood plain with the rest having potential for urban development and owned by private parties. The construction of the dam will require the relocation of one 4 inch waterline and concrete encasement around a second 4 inch waterline. Concrete encasement is planned around a telephone cable where it passes under the proposed dam. A residential powerline will be relocated.

-Improvements to Be Installed-

The construction of Sunnycove Dam will require the acquisition of 25 acres of land for the floodwater and sediment pools and the detention dam with side spillway. The City of Wickenburg owns 15 acres of the land with private parties owning the rest. Approximately 6 acres of the land is in the 100-year flood plain of Sunnycove Wash with the rest being undeveloped relatively steep broken lands. No relocation of utilities is expected at the site.

The construction of the outlet pipeline will require the acquisition of 1.5 acres of private land and the use of 2.5 acres of city owned land. About one-half of the city owned land needed is existing streets. The sponsors will replace pavement damaged during construction.

Sixteen utility lines will be crossed by the outlet pipeline. These utilities include 8 sewer lines, 7 water lines, and one gas line.

No relocation of people or businesses is expected from the construction of the works of improvement included in the plan.

## EXPLANATION OF INSTALLATION COSTS

### LAND TREATMENT MEASURES

The cost of establishing the land treatment measures prescribed in the work plan include:

1. The costs of applying the required measures.
2. The costs of providing the technical assistance.

The land treatment measures needed on the federal lands have been completed in conformance with the policies and standards of the land administering agency and the Soil Conservation Service. Therefore, no costs have been included in the plan for land treatment measures on federal land.

The quantity-unit cost approach is used to estimate the cost of installing the land treatment measures on the non-federal land. The costs of applying the land treatment measures described in the plan will be borne by the individual landowners or operators except for the treatment of approximately 500 acres classified as critical. The cost of treatment of the critical areas will be shared 80 percent from P. L. 566 funds and 20 percent from other funds.

Cost estimates for technical assistance are based on similar costs encountered for the existing conservation program in the area. Technical assistance costs to install the land treatment measures will be borne by current program funds and P. L. 566 funds. The technical assistance costs to complete the low intensity soil survey on the Maricopa County portion of the watershed will be borne by P. L. 566 funds.

### STRUCTURAL MEASURES

The total installation cost for structural measures includes cost of construction, engineering services, project administration, state dam filing fees, and land rights. A tabulation of the installation costs is shown in Table 2 of this plan.

#### Construction

The construction costs shown in the plan include the cost of materials, equipment, labor, and profit associated with the construction of the works of improvement. The estimated construction costs include a contingency factor of 15 percent on dams and 20 percent on the pipelines.

### Engineering Services

The cost of engineering services includes services of engineers, hydrologists, and geologists for surveys, site investigations, soil mechanics, structural designs, flood routing, and construction plans and specifications. Engineering costs are estimated at twenty percent of the construction cost. (Table 2)

### Project Administration

The costs of project administration are the P. L. 566 and other administration costs associated with the installation of structural measures. This cost includes the cost of contract administration, review of engineering plans prepared by others, government representatives, construction layout, and necessary inspection service during construction to insure that structural measures are installed in accordance with the plans and specifications. Project administration costs for P. L. 566 and other funds are estimated at ten and one percent of the construction cost, respectively. The State of Arizona dam filing fee is an additional administrative cost paid by other funds. The local sponsors are responsible for providing the entire cost of relocation assistance advisory services if the need for relocation payments develops before the construction of the project. The cost of other administrative duties associated with relocation payments will be borne by the party that incurs the costs.

### Land Rights

Land rights costs estimates were made by the sponsoring local organizations. The major land rights costs are those for land acquisition, estimated at \$53,200. The cost of relocation of utilities and the paving of streets is estimated at \$4,360.

### Relocation Payments

It is anticipated that relocation payments will not be needed on this project. If the need for relocation develops before construction of the project, the relocation payments will be cost shared, in proportion to the local sponsors and Service's cost of the project, 32.9 percent by the sponsors and 67.1 percent by the Service. Some items included in relocation payments are: moving and related expenses, replacement housing costs, and losses sustained while re-establishing a farm or business.

## COST SHARING

The total estimated installation cost of the project is \$553,560, of which \$371,260 are from P. L. 566 funds and \$182,300 are from other funds. All costs are allocated to flood prevention.

The following will be borne by P. L. 566 funds:

1. The cost of construction of structural measures. (Estimated cost of \$230,580.)
2. The cost of engineering services for all structural measures. (Estimated cost of \$46,110.)
3. The cost of project administration incurred by the Soil Conservation Service. (Estimated cost \$23,060.)
4. The cost of technical assistance to accelerate the soil surveys in the Maricopa County portion of the watershed. (Estimated cost \$16,000.)
5. The cost of accelerated technical assistance to install the land treatment measures. (Estimated cost \$7,510.)
6. Eighty percent of the cost of installing land treatment measures on about 500 acres needing critical area treatment. (Estimated cost \$48,000.)

The following will be borne by Other Funds:

1. Twenty percent of the cost of installing land treatment measures on critical areas. (Estimated cost \$12,000.) All of the cost of other land treatment measures (Estimated cost \$101,695.)
2. The cost of technical assistance which is not a part of the accelerated land treatment program. (Estimated cost \$7,175.)
3. The cost of project administration incurred by the sponsors. (Estimated cost \$3,870.)
4. The total cost of land rights for the structural measures. (Estimated cost \$57,560.)

EXPECTED EXPENDITURES OF FUNDS BY FISCAL YEARS

Wickenburg Watershed, Arizona  
(Dollars)<sup>1/</sup>

	FISCAL YEARS				Total
	1	2	3	4	
<u>P. L. 566 FUNDS</u>					
<u>LAND TREATMENT</u>					
Critical Area Treatment	12,000	12,000	12,000	12,000	48,000
Technical Assistance	17,985 <sup>2/</sup>	2,315	1,575	1,635	23,510
<u>STRUCTURAL MEASURES</u>					
Construction		230,580			230,580
Engineering Services	23,055	23,055			46,110
Project Administration		23,060			23,060
TOTAL P. L. 566	53,040	291,010	13,575	13,635	371,260
<u>OTHER FUNDS</u>					
<u>LAND TREATMENT</u>					
Cropland	225	135	65	135	560
Rangeland	26,640	26,830	23,645	24,020	101,135
Critical Area Treatment	3,000	3,000	3,000	3,000	12,000
SCS Technical Assistance	3,270	1,255	1,635	1,015	7,175
<u>STRUCTURAL MEASURES</u>					
Project Administration		3,870			3,870
Land Rights	31,920	25,640			57,560
TOTAL OTHER FUNDS	65,055	60,730	28,345	28,170	182,300
TOTAL	118,095	351,740	41,920	41,805	553,560

<sup>1/</sup> Price base 1972 prices.

<sup>2/</sup> Includes estimated cost of accelerated soil surveys for Maricopa County portion of the watershed of \$16,000.

## EFFECTS OF WORKS OF IMPROVEMENT

The land treatment measures will reduce the erosion of the upper watershed by increasing the density of cover and by slowing down the flow of the water through the use of waterspreader systems. It is estimated that the sediment delivered by Sols Wash to the Hassayampa River will be reduced by about 3,850 tons per year due to the land treatment program. About 1,000 tons per year of this reduction is attributable to critical area treatment.

The structural measures on Sunset-Sunnycove Wash will reduce the annual sediment delivery from that wash by about 450 tons per year.

The completion of the structural and land treatment program will reduce the average annual sediment delivered to the Hassayampa River by the watershed washes from 60,000 tons to 55,700 tons. The average suspended sediment concentration of the flows in the watershed washes will be reduced from 20,000 mg/l to about 18,600 mg/l.

The installation of the land treatment measure, waterspreader systems, will result in clearing some native vegetation during construction, but, by providing more water to the area upstream from the spreaders and around the end of the spreaders, the overall effect will be to increase the vegetation on the land. It is estimated that for every acre of land cleared to construct the systems, increased vegetation should occur on at least three acres. This vegetation will be available for use by both wildlife and livestock.

The proposed structural program will substantially reduce floodwater and sediment damages along the Sunset-Sunnycove Wash.

It is estimated that under present conditions the 100-year peak flow that would occur at the Sunset-Sunnycove junction is 1,590 cfs. The construction of the proposed works of improvement will reduce the 100-year peak at this location to 690 cfs. Existing channels will be maintained to accommodate this flow that originates below the dams.

The construction of the two floodwater retarding structures will reduce the area flooded by the 100-year flood from 69 acres to 10 acres. Presently 110 homes are located in the 69-acre flood plain with 75 of these being subject to floodwater and sediment damages by water getting inside the homes. Following construction of the proposed structural program, only one house will still be subject to floodwater and sediment damage by water getting inside it during the 100-year flood. This one home has a partially completed floodproofing wall built around it, and completion of this wall would protect the home from the after project 100-year flood. The protection provided by the floodwater retarding structures will prevent 8 acres of irrigated pastureland from being flooded by Sunset-Sunnycove Wash flows. These 8 acres

will still be subject to flooding from the Hassayampa River. The 10 acres that still will be flooded after construction of the proposed works of improvement, except for the house mentioned, are presently being used as streets, yards, or channels. The depth of flooding on these areas will be reduced 1.3 feet for the 100-year flood by the structures.

Figure 3, Urban Flood Plain Map shows the areas that would be flooded by the once in 100-year flood event with and without the proposed project. The area flooded on Casandro Wash and Sols Wash will remain the same.

The use of buried pipe for outlets will require disturbance of the area needed for installation of the pipe, mainly streets and existing channels during the construction period. After completion of construction, the outlets will not be noticeable throughout their entire length, except for the inlet and outlet structures. Some interruption of local traffic will result during the installation of the pipes, especially where the pipe is placed under existing streets. Very little vegetation will be removed by the installation of the buried pipe outlets.

The construction of the two floodwater retarding structures will require the clearing of approximately 15 acres of land currently occupied by scattered creosote bush, mesquite, palo verde, various cacti, small shrubs, and grasses. The area cleared will be kept to the minimum needed to construct the works of improvement and provide the needed borrow. During construction, some dust can be expected from the sites, and the disturbed areas will be subject to more erosion than if left in the natural state. Following construction, all areas disturbed will be revegetated with native grasses, shrubs, and trees. To speed the recovery of natural revegetation, some plants will be salvaged and transplanted on the disturbed areas. Until the vegetation becomes well established on the earth structures, the unvegetated fill will be visible from many homes in the area.

The temporary storage area necessary to provide the 100-year protection to the downstream flood plain, and the land needed to construct the structures will require the commitment of 9.6 acres at the Sunset site and 18.5 acres at the Sunnycove site.

Vegetative growth will be enhanced on the acres subjected to temporary inundation during periods of high runoff. The increased infiltration of water into the soil during temporary impoundment will be available for plant utilization after drawdown occurs.

The inventory made by Arizona Game and Fish Department and the Bureau of Sport Fisheries and Wildlife indicates that the construction of the structural program will not significantly affect the wildlife

resources of the watershed. No rare and endangered species were identified in the areas that will be disturbed by the project.

The construction of the project will relieve the current atmosphere of tension that exists for the people living on the Sunset-Sunnycove flood plain during a rainstorm. They will be able to get to work and keep their utilities in operation rather than expecting them to be washed out every time it rains. While some damages will still occur, they are limited in size and will not be impossible to handle.

It is not expected that anyone will be relocated because of the land needed to install the project. If development occurs, between the present time and when the project is constructed on land needed, these people will be relocated in accordance with procedures outlined in the work plan agreement.

## PROJECT BENEFITS

Total flood prevention benefits accruing to project structural measures on the Sunset-Sunnycove reach are estimated to be \$35,570 annually. Direct flood damage reduction benefits amount to \$31,050 and reductions in indirect damages amount to \$4,520.

Direct damage reduction benefits to non-agricultural property are estimated at \$31,050. This includes \$23,080 for floodwater damage reduction and \$7,970 for sediment damage reductions.

Reduction of indirect damage is estimated to be \$4,520, all of which is non-agricultural damage.

Secondary benefits were not evaluated.

## COMPARISON OF BENEFITS AND COSTS

The average annual benefits to accrue as a result of the installation of the proposed structural measures are estimated to be \$35,570. The average annual cost of the proposed structural measures are estimated to be \$21,120. The ratio of average annual benefits to average annual costs is 1.7:1.0.

## PROJECT INSTALLATION

The execution of this work plan will be a coordinated effort involving federal agencies, local landowners, and various local organizations. The local organizations involved include the town of Wickenburg, Flood Control District of Maricopa County, State of Arizona, Wickenburg Natural Resource Conservation District, and the Triangle Natural Resource Conservation District. The federal agencies include the Bureau of Land Management of the U. S. Department of Interior; and the Agricultural Stabilization and Conservation Service and Soil Conservation Service of the U. S. Department of Agriculture. In order to coordinate the installation of the works of improvement, specific responsibilities will be required of all involved.

The Wickenburg and Triangle Natural Resource Conservation Districts and the Flood Control District of Maricopa County will have the primary responsibility for accomplishing the proposed plan.

### The Wickenburg and Triangle Natural Resource Conservation Districts will:

1. Provide assistance and encouragement to landowners and operators in the Districts to assure the application of the land treatment measures outlined in this work plan.
2. Administer the installation of the critical area treatment on approximately 500 acres.
3. Conduct an information and education program to properly inform local people of the project.

### The Flood Control District of Maricopa County will:

1. Carry out and assume the responsibility and all liability for the construction, operation, and maintenance of structural measures.
2. Carry out needed legal surveys and acquire all land rights needed in connection with the structural works of improvement. The power of eminent domain will be exercised if necessary.
3. Acquire or provide assurance that any necessary water rights required by state law have been acquired by landowners or water users.

-Project Installation-

4. Provide relocation assistance, relocation advisory assistance, and make relocation payments if any person is displaced by the project. At the present time no displacement is expected.
5. Assure that the land needed for construction of the project is appraised according to normal procedures, and that the price offered for the land is equitable.

The Bureau of Land Management will:

1. Continue to exercise control of grazing on federal land in the watershed by licensing the number of livestock and time of use to insure vegetative cover.
2. Plan for the best use or uses of federal land in this area under the Multiple Use Act. Land treatment measures on federal land will be planned and applied as a coordinating conservation effort to be in harmony with the determined land use and provide for overall conservation treatment of the watershed.
3. Provide technical supervision on any projects in the watershed initiated by the Bureau of Land Management or other authorized users of the federal land.

The Bureau of Land Management has reviewed and concurred in the features of this plan relating to land under its jurisdiction.

The Soil Conservation Service will:

1. Furnish accelerated technical assistance through the Wickenburg Natural Resource Conservation District and Triangle Natural Resource Conservation District to private landowners for the application of land treatment measures outlined in this work plan using current program funds and P. L. 566 funds.
2. Allot P. L. 566 funds to provide 80 percent cost sharing for the installation costs of land treatment on the approximately 500 acres of land identified as critical areas.
3. Furnish engineering services for engineering surveys, design, land rights work map, construction plans, and specifications for structural works of improvement for flood prevention and inspection during construction.
4. Allot P. L. 566 construction funds in accordance with cost sharing and the installation schedule as outlined in this plan or as may be revised by mutual agreement. Allocations of funds will be in accordance with national priorities and availability at the time of installation.

5. Maintain liaison with sponsors and state and federal agencies involved so that the objectives outlined in this plan will be accomplished for the benefit of all concerned.
6. Provide the technical assistance funded by P. L. 566 to do a low intensity soil survey for the Maricopa County portion of the watershed.
7. If relocation becomes necessary during the installation period, provide assistance to the Flood Control District of Maricopa County to assure meeting the provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894).

The installation of structural measures will begin as soon as practical after the approval of the work plan and allocation of P. L. 566 funds for participation in the project. A four year installation period is planned for the project. The structural measures will be installed within the first two years. Land treatment measures will be installed in each of the four years and will be completed during the fourth year.

The following schedule will be followed to meet the four year installation period:

#### First Year

All land rights for the Sunset Wash Floodwater Retarding Structure and buried pipe outlet will be secured. All necessary surveys and investigations for the floodwater retarding structures and outlets will be completed and detailed designs completed on the Sunset Wash FRS. The low intensity soil survey for the Maricopa County portion of the watershed will be started and completed. Installation of land treatment measures will be started.

#### Second Year

All land rights for the Sunnycove Wash FRS and buried pipe outlet will be secured. Detailed designs will be completed on Sunnycove Wash FRS and the outlets of both structures. Specifications and plans will be completed, and the contract for construction will be awarded. Construction of the structural works of improvement will be completed and all areas disturbed during construction will be revegetated with native grasses, shrubs, and trees. Installation of land treatment measures will continue.

Third Year

Installation of land treatment measures will continue.

Fourth Year

The installation of land treatment measures will be completed. Any additional revegetation work needed on structural works of improvement will be done.

## FINANCING PROJECT INSTALLATION

Project costs to be shared by Public Law 566 funds will be paid out of funds appropriated under the authority of Public Law 566, 83rd Congress, 68 Stat. 666, as amended. This work plan does not constitute a financial document for obligation of either federal or other funds including those of the local sponsors. Financial or other assistance to be furnished by the Soil Conservation Service in carrying out the plan is contingent on the appropriation of funds for this purpose.

### LAND TREATMENT

The SCS, using P. L. 566 funds, will pay up to 80 percent of the installation cost of the critical area treatment through the Triangle and Wickenburg Natural Resource Conservation Districts. Private landowners or lessees of state trust lands on which critical area treatment is installed will bear all costs not borne by P. L. 566 funds.

The cost of applying land treatment, other than critical area treatment, on private and state trust lands will be borne by the private landowner or the lessees of state trust lands. Financial assistance may be available from the Agricultural Stabilization and Conservation Service through the Rural Environmental Conservation Program or from the Four Corners Regional Commission.

Technical assistance will be provided by the Soil Conservation Service at an accelerated rate using the current program and P. L. 566 funds. The cost of the low intensity soil survey on the Maricopa County portion of the watershed will be borne by P. L. 566 funds.

### STRUCTURAL MEASURES

Structural installation costs not borne by P. L. 566 funds will be the responsibility of the Flood Control District of Maricopa County. The District has analyzed its financial needs in consideration of the scheduled works of improvement so that funds will be available when needed through cash resources or tax and assessment levies. The installation cost referred to as land rights is the responsibility of the sponsors. Land rights may be negotiated for or acquired by eminent domain.

No relocation payments are anticipated for this project. However, if some become necessary before the project is installed, the Flood Control District of Maricopa County will be responsible for providing the Non-P. L. 566 relocation costs and the entire cost of relocation assistance advisory services. The funds for these costs will be obtained, as mentioned above, from the current program of the Flood Control District.

## PROVISIONS FOR OPERATION AND MAINTENANCE

### LAND TREATMENT MEASURES

Landowners and operators cooperating with the Wickenburg Natural Resource Conservation District and the Triangle Natural Resource Conservation District will be responsible for the maintenance of land treatment measures installed on their property, including state leases.

Land treatment measures on federal lands will be maintained by the Bureau of Land Management or the lessees.

### STRUCTURAL MEASURES

The Flood Control District of Maricopa County will be responsible for the operation and maintenance of all structural measures after installation. The District will obtain all necessary funds for operation, maintenance, and replacement from tax or assessment levies.

A sponsor's representative and the Soil Conservation Service will make a joint annual inspection of the structures during the first three years after installation. After the three year period, annual inspections will be made by the sponsors; and a report will be sent to the Soil Conservation Service. Inspection will also be made after unusually large floods.

An operation and maintenance agreement will be entered into between the sponsors and the Soil Conservation Service prior to the signing of a land rights or project agreement.

The total annual operation, maintenance, and replacement cost of structural measures is estimated to be \$1,160.

It is agreed that representatives of the federal, state, and county government shall have free access at all times to the structural works of improvement for official activities.

All phases of operation and maintenance of these facilities shall comply with applicable local, state, and federal regulations.

Items considered necessary for proper operation and maintenance of the structural works of improvement shall include, but are not limited

to, the following:

Operation

The structural measures for flood prevention are automatic in operation. The principal spillways of both dams are ungated and will allow the floodwaters to discharge into the outlet works and into the Hassayampa River as soon as the floodwater enters the reservoir area.

Maintenance

Proper functioning of the structural works will require periodic maintenance.

All structures are to be maintained by making repairs or replacements as needed.

Trash and obstructions are to be removed from the principal spillway inlet during and after storm events. Repairs to structures or structural features damaged by floods will be made promptly.

Further guidelines regarding operation and maintenance procedures are given in the Arizona Watershed Operation and Maintenance Handbook. Sponsors of the project have copies of the handbook on file.

**TABLE 1 - ESTIMATED PROJECT INSTALLATION COST**  
Wickenburg Watershed, Arizona

Installation Cost Item	Unit	Number	Estimated Cost (Dollars) 1/		Total	
		Non-Fed. Land	Non-Federal Land P.L. 566 SCS 2/	Other SCS 2/		
<b>LAND TREATMENT</b>						
Pastureland 3/	Ac.	100		560	560	
Rangeland 3/	Ac.	31,650		101,135	101,135	
Critical Area Treatment Waterspreading Systems	Ac.	500	48,000	12,000	60,000	
Critical Area Planting	Ac.	(500)	(36,000)	(9,000)	(45,000)	
Grazing Land Mechanical Trtmt.	Ac.	(500)	(8,000)	(2,000)	(10,000)	
Technical Assistance			(500)	(4,000)	(1,000)	(5,000)
			23,510 4/	7,175	30,685	
<b>TOTAL LAND TREATMENT</b>		<b>32,250</b>	<b>71,510</b>	<b>120,870</b>	<b>192,380</b>	
<b>STRUCTURAL MEASURES</b>						
Construction						
Floodwater Retarding Structures	No.	2	152,760		152,760	
Outlet Pipelines (M) 5/	Ft.	9,005	77,820		77,820	
<b>Subtotal - Construction</b>			<b>230,580</b>		<b>230,580</b>	
Engineering Services			46,110		46,110	
<b>Subtotal - Engineering Services</b>			<b>46,110</b>		<b>46,110</b>	
Project Administration						
Construction Inspection			13,840		13,840	
Other			9,220	3,870	13,090	
<b>Subtotal - Project Administration</b>			<b>23,060</b>	<b>3,870</b>	<b>26,930</b>	
Other Costs						
Land Rights				57,560	57,560	
<b>Subtotal - Other Costs</b>				<b>57,560</b>	<b>57,560</b>	
<b>TOTAL STRUCTURAL MEASURES</b>			<b>299,750</b>	<b>61,430</b>	<b>361,180</b>	
<b>TOTAL PROJECT</b>			<b>371,260</b>	<b>182,300</b>	<b>553,560</b>	

1/ Price base 1972 prices.

2/ Federal agency responsible for assisting in installation of works of improvement.

3/ Includes only areas estimated to be adequately treated during the project installation period. Treatment will be accelerated throughout the watershed, and dollar amounts apply to total land areas, not just to adequately treated areas.

4/ Includes the estimated cost of accelerated soil surveys in the Maricopa County portion of the watershed of \$16,000.

5/ Type of channel before project: (M) manmade ditch or previously modified channel; (N) - an unmodified well defined natural channel or stream; (O) - none or practically no defined channel.

Note: The existing channel will be left in its present condition. The outlet pipelines will be placed along or under the existing channels.

**TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT**  
(At time of work plan preparation)

Wickenburg Watershed, Arizona

Measures	Unit	Applied To Date	Total Cost (Dollars) 1/
<b>LAND TREATMENT</b>			
<b>Non-Federal Land</b>			
Brush Control	acre	1,920	19,200
Dam, Diversion	number	2	600
Deferred Grazing	acre	15,355	1,540
Fencing	mile	4	1,900
Irrigation Ditch & Canal Lining	feet	3,960	11,880
Irrigation Land Leveling	acre	37	2,960
Irrigation Pipeline	feet	2,820	11,280
Irrigation System, Sprinkler	number	3	45,000
Irrigation Water Management	acre	18	10
Pasture and Hayland Management	acre	51	50
Pasture and Hayland Planting	acre	92	1,380
Pipeline, Stockwater	feet	15,100	59,610
Pond	number	21	12,750
Proper Grazing Use	acre	47,933	3,820
Range Seeding	acre	600	4,800
Well	number	9	15,300
Subtotal			192,080
<b>Federal Land</b>			
Fencing	mile	2	1,800
Proper Grazing Use	acre	4,000	200
Subtotal			2,000
<b>TOTAL</b>			<b>194,080</b>

1/ - Price Base 1972

March 1974

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Wickenburg Watershed, Arizona

(Dollars) 1/

Item	Installation Cost					Total Install. Cost
	P.L. 566 Funds			Other Funds		
	Con- struction	Engin- neering	Total P.L. 566	Land Rights	Total Other	
Floodwater Retarding Structures						
Sunset	75,690	15,140	90,830	29,270 <u>2/</u>	29,270	120,100
Sunnycove	77,070	15,410	92,480	22,980	22,980	115,460
Outlet Pipelines (M) <u>5/</u>	77,820	15,560	93,380	5,310 <u>3/</u>	5,310	98,690
Subtotal	230,580	46,110	276,690	57,560	57,560	334,250
Project Administration			23,060		3,870 <u>4/</u>	26,930
GRAND TOTAL	230,580	46,110	299,750	57,560	61,430	361,180

1/ Price base 1972 prices.

2/ Includes \$27,770 for right-of-way and \$1,500 for utility relocation.

3/ Includes \$2,450 for right-of-way, \$2,400 for utility relocation, and \$460 for pavement repair.

4/ Includes \$1,560 for State of Arizona dam filing fees.

5/ Type of channel before project: (M) manmade ditch or previously modified channel.

Note: The existing channel will be left in its present condition. The outlet pipelines will be placed along or under the existing channels.

March 1974

**TABLE 3 - STRUCTURAL DATA**  
**STRUCTURES WITH PLANNED STORAGE CAPACITY**  
**Wickenburg Watershed, Arizona**

Item	Unit	Sunset	Sunnycove	Total
Class of Structure		c	c	
Drainage Area	Sq. Mi.	0.60 = 804Ac	1.35 = 1644Ac	1.95
Curve No. (1-day) (AMC II)		75.	83.	
Tc	Hrs.	0.33	1.10	
Elevation Top of Dam	Ft.	2,140.50	2,178.50	
Elevation Crest Emergency Spill.	Ft.	2,131.00	2,173.00	
Elevation Crest Principal Spill.				
High Stage	Ft.	2,130.50	2,172.00	
Low Stage	Ft.	2,115.00	2,136.00	
Maximum Height of Dam	Ft.	30.50	47.00	
Volume of Fill	Cu. Yds.	31,400	62,500	93,900
Total Capacity 1/	Ac. Ft.	71.10	244.20	315.30
Sediment Storage 100 Years	Ac. Ft.	8.10	18.20	26.30
Retarding	Ac. Ft.	63.00	226.00	289.00
Between high and low stage	Ac. Ft.	56.00	210.00	262.00
Surface Area				
Sediment Pool	Acres	2.50	2.70	5.20
Retarding Pool	Acres	9.60	18.50	28.10
Principal Spillway				
Rainfall Volume (areal) (1 day)	In.	4.20	4.20	
Rainfall Volume (areal) (10 day)	In.	6.50	6.50	
Runoff Volume (10 day)	In.	2.03	3.14	
Capacity of Low Stage (Max.)	cfs.	5.50	6.00	
Frequency Operation-Em. Spill.	% Chance	Less than 1	Less than 1	
Size of Conduit (Diameter)	In.	30.	30.	
Emergency Spillway Design				
Rainfall Volume (ESH) (areal)	In.	7.42	7.42	
Runoff Volume (ESH)	In.	4.51	5.42	
Storm Duration	Hrs.	6.	6.	
Type		R/C Chute	Earth	
Bottom Width	Ft.	40.	250.	
Velocity of Flow (V <sub>e</sub> )	Ft./Sec.	8.58	6.47	
Slope of Exit Channel	Ft./Sec.	.333	0.029	
Maximum Water Surface Elev.	Ft.	2,134.71	2,175.97	
Freeboard Design				
Rainfall Volume (FH) (areal)	In.	19.00	19.00	
Runoff Volume (FH)	In.	15.51	16.74	
Storm Duration	Hrs.	6.00	6.00	
Maximum Water Surface Elev.	Ft.	2,140.25	2,178.21	
Capacity Equivalents				
Sediment Volume	In.	0.25	0.25	
Retarding Volume	In.	1.97	3.14	

1/ Crest of Emergency Spillway

March 1974

TABLE 3A - STRUCTURAL DATA  
CHANNELS  
Wickenburg Watershed, Arizona

Channel Name	Station	CAPACITY (cfs)			TYPE OF WORK 1/ Outlet Pipeline 2/ (dia.)	BEFORE PROJECT	
		Required For 1% Peak After Project	Existing Channel 1/	Outlet Pipeline 2/		Type of Channel	Flow Condition
Sunny-cove	10+80 to 41+14.5	230	400	6.0	12 in.	M 3/ (1950- 1960)	E 4/
Sunset	14+54 to 22+00	20	550	5.5	12 in.	M (1960)	E
Sunset	20+00 to 35+46	460	480	5.5	12 in.	M (1960)	E
Sunset	35+46 to 52+00	690	720	11.5	18 in.	M (1940- 1960)	E
Sunset	52+00 to 64+00	690	580	11.5	18 in.	M (1960)	E
Sunset	64+00 to 76+00	700	800	--	None	M (1960)	E

- 1/ The size and location of the existing channel will not be changed by the proposed works of improvement. The outlet pipeline will be constructed beside or under the existing channel.
- 2/ The pipeline will carry the water stored behind the floodwater retarding structures through the urban areas to the Hassayampa River flood plain.
- 3/ M - Manmade or modified channel (the date of modification varies from 1940 to 1960).
- 4/ E - Ephemeral - flows only during periods of surface run-off, otherwise dry.

March 1974

**TABLE 4 - ANNUAL COSTS**  
Wickenburg Watershed, Arizona  
(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost <u>2/</u>	Operation and Maintenance Cost	Total
Sunset Dam	6,640	380	7,020
Sunnycove Dam	6,380	390	6,770
Outlet Pipelines	5,450	390	5,840
Project Administration	1,490	xxx	1,490
<b>GRAND TOTAL</b>	<b>19,960</b>	<b>1,160</b>	<b>21,120</b>

1/ Price Base 1972

2/ 100 years @ 5-1/2 percent interest

March 1974

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Wickenburg Watershed, Arizona

Sunset-Sunnycove Reach

(Dollars) 1/

	<u>Estimated Average Annual Damage</u>		<u>Damage Reduction Benefit</u>
	<u>Without Project</u>	<u>With Project</u>	
Floodwater			
Nonagricultural			
Residential	22,930	110	22,820
Streets	790	390	400
Subtotal	23,720	500	23,220
Sediment			
Nonagricultural			
Residential	7,320	30	7,290
Streets	1,440	720	720
Subtotal	8,760	750	8,010
Indirect	4,540	20	4,520
TOTAL	37,020	1,270	35,750

1/ Price Base 1972

March 1974

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Wickenburg Watershed, Arizona

(Dollars)

Evaluation Unit	Average Annual Benefits		Average Annual Costs 3/	Benefit Cost Ratio
	Damage Reduction 1/	Total		
Floodwater Retarding Structures and Outlet Pipelines	35,570	35,570	19,630	1.8:1.0
Project Administration	xxx	xxx	1,490	xxx
GRAND TOTAL	35,570 2/	35,570	21,120	1.7:1.0

1/ Price Base - 1972

2/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of \$180 annually on Sunset-Sunnycove Wash.

3/ From Table 4

March 1974

INVESTIGATIONS AND ANALYSES

WICKENBURG WATERSHED

Maricopa and Yavapai Counties,  
Arizona

LAND USE AND TREATMENT

HYDROLOGIC INVESTIGATIONS

GEOLOGIC INVESTIGATIONS

SEDIMENTATION INVESTIGATIONS

ENGINEERING INVESTIGATIONS

ECONOMIC INVESTIGATIONS

FISH AND WILDLIFE INVESTIGATIONS

## LAND USE AND TREATMENT

Land treatment measures to be applied by farmers and ranchers cooperating with the Wickenburg Natural Resource Conservation District and the Triangle Natural Resource Conservation District are an essential part of the work plan. These proposed measures were based on soil surveys, technical guide data, conservation needs inventory, range site inventories, and past accomplishments of the going program of the Natural Resource Conservation Districts. The inventories reveal a need for critical area treatment on 500 acres.

The cost of technical assistance for installation of the land treatment measures was based on the average work performance time for each of the individual measures to be applied. An average hourly rate was established to fit local conditions using Advisory Notice B&F - Arizona 2, dated February 1, 1973, as a guide. Available technical assistance of the going program, based on past records, is not adequate to meet the needs of the planned land treatment program. Therefore, P. L. 566 funds will be used, along with the going program funds, to provide the needed technical assistance to install the land treatment measures and to conduct the low intensity soil survey on the Maricopa County portion of the watershed.

The costs of establishing the proposed land treatment program outlined in this plan were estimated by using current cost records for similar work being done under the going program of the Natural Resource Conservation Districts. The estimated costs were also compared with cost data from other similar agricultural areas in the state.

## HYDROLOGIC INVESTIGATIONS

### Basic Data

One National Weather Service standard rain gage is located in the watershed. There are no stream gages located in the watershed. Rainfall amounts from the rain gage were analyzed and found to be lower than revised TP-40 map amounts for 24-hour duration storms. The local newspaper indicated that the majority of the storms in this area are of 2 hour to 6 hour duration. The revised TP-40 map rainfalls were used to design and evaluate the project.

Soil and cover reconnaissance surveys were made of the watershed by the Soil Conservation Service soil scientist and range conservationist. From their data, runoff curve numbers were calculated using procedures outlined in Chapters 7, 8, and 9 of the National Engineering Handbook, (NEH), Section 4.

Times of concentration were derived from stream channel hydraulics. Channel cross-sections were taken at several locations and velocities computed. Procedures outlined in Chapter 15, National Engineering Handbook, Section 4, were used.

Digital computer facilities available at the E&WP Unit were used in project evaluation and flood routing.

### Floodwater Retarding Structures

The floodwater retarding structures were designed to retard the 100-year runoff volumes calculated using the principles outlined in Chapter 21, NEH, Section 4.

The emergency spillway and freeboard hydrographs were computed using criteria established in Engineering Memorandum SCS-27 (Rev.) and the techniques described in Chapter 21, NEH, Section 4.

The design rainfall was determined by using the revised TP-40 map rainfall and ES-1020 sheet 5 of 5.

### Damage-Frequency Analysis

A topographic map was obtained of the town with a scale of 1 inch equals 80 feet and a contour interval of 2 feet. All building locations and floor elevations; of the buildings on the flood plain, were shown on the map. Stage-discharge relationships were defined by using uniform flow relations from surveyed cross-sections located on the maps.

Using the computer program outlined in Technical Release 20, a peak discharge versus frequency curve was developed. This curve was developed based on Revised TP-40 map rainfall and the computed peak rates of runoff for the 1, 2, 4, 10, 20, and 50 percent chance storms. Peak discharges and the stage-discharge relationship were used to plot the area inundated on the topographic map. From the stage-discharge relationships, the elevation of the water surface at each evaluation point was determined. The depth of flooding at any point was calculated from these data.

The synthesized peaks and area flooded were compared with the values printed in the Army Corps of Engineers' Wickenburg Report of 1965. Both the peak flow and the area flooded by the one percent event were in close agreement on all washes except Sols.

On August 17, 1971, Sols Wash had a major flow, which according to local residents, was the largest in at least the last 47 years. Based on slope-area measurements, the Soil Conservation Service estimated the peak discharge of this storm to be 9,500 cfs. The USGS also made slope-area measurements of this flow and estimated the peak discharge of the storm to be 10,600 cfs with the measurement being rated poor. The synthesized four percent storm, through use of the TR-20 program for Sols Wash, was calculated to be 9,750 cfs.

## GEOLOGIC INVESTIGATIONS

Foundation investigations were made by surficial inspection and by the digging of backhoe pits along or in close proximity to the proposed dam centerlines. The pits were logged, and soil samples were taken for testing of their engineering properties.

### Sunset Wash

The site is located in a narrow section of the valley in Section 11, T7N, R5W. Looking upstream from the site, the valley quickly widens, forming a moderately sloping alluvial plain. The damsite abutment surfaces are composed of silty, sandy, gravelly alluvial material. The materials found in the valley bottom consist of Quaternary silt, sand, and gravel.

Three backhoe pits were dug along the proposed dam centerline to determine the types of materials present in the foundation. Caliche material was found in each of the pits at depths varying from 4.0 feet to 6.5 feet. The caliche is overlain by silty, sandy gravel, and silty sand. Disturbed soil samples were taken from selected pits.

The emergency spillway will be a reinforced concrete chute located on the dam.

The foundation material is competent to support the loads to be imposed. A core trench in the caliche material will prevent any excessive seepage through the foundation.

The materials in the borrow area located upstream from the centerline of the dam were considered similar to the materials found along the centerline. The predominant material available for borrow is the silty sand.

### Sunnycove Wash

The site is located at the confluence of two washes, Sunnycove Wash and tributary. The abutments consist of coarse to subangular, arkosic conglomerate, and fine fanglomerate beds that are moderately to firmly cemented (conglomerate-fanglomerate material). This material is capped by sand, silt, and gravel.

A total of four backhoe pits were dug along the proposed centerline. The conglomerate-fanglomerate material was encountered in each of the pits. The depths of this material varied from one foot to nine feet.

The overburden materials consist of silty, gravelly sand and poorly graded sand. The thicker overburden is found in the wash.

The principal location of borrow material is along the channel bank, both upstream and downstream from the damsite and the left abutment where the emergency spillway will be excavated. The material along the channel bank is primarily silty, clayey, gravelly sand. The material in the left abutment is primarily conglomerate-fanglomerate. An alternate borrow area near the old city dump, three-fourths of a mile southwest of the damsite, was investigated. The material encountered was a sandy, silty, gravelly clay.

A generalized geology map was made of the area near the damsite. This map shows the areas of conglomerate-fanglomerate outcrops.

The site is suitable for the construction of an earth embankment. The conglomerate-fanglomerate material is a suitable foundation for the structure.

The emergency spillway will be located in the left abutment. The crest of the emergency spillway will be in the erosion-resistant conglomerate-fanglomerate.

## SEDIMENTATION INVESTIGATIONS

A sediment survey was conducted on the watershed to estimate the sediment yield delivered to the proposed structures. The survey was made using ground cover survey data, topographic maps, inspection of the watershed, and sediment surveys on two stock ponds. All of the data was evaluated, and a sediment yield rate for the watershed above each structure was determined.

The range method was used to survey the two ponds, Wellick Tank and Pouquette Tank. The location and distance between ranges were determined according to the configuration of the pond. The ranges were essentially placed so they were perpendicular to the incoming flow.

The volume of sediment and the original volume of the stock ponds were computed using the range-area method. The trap efficiency of each pond was estimated by using the capacity-inflow ratio curve. The total trapped sediment was adjusted accordingly.

The sediment yield to each pond was determined by dividing the measured and adjusted volume of sediment, by the age of the pond (if cleaned, from date cleaned to date survey was taken), and further dividing by the area of the watershed. If the rainfall was excessive or deficient during the years of sediment accumulation, the sediment yield was adjusted accordingly.

The sediment survey on the Wellick Tank revealed that the tank was receiving, on the average, 0.12 acre-feet of sediment per year. The watershed area above the structure is about .79 square mile. The watershed surface materials consist mainly of Quaternary-Tertiary silt, sand, and gravel. The vegetative cover is about 13 percent. The adjusted estimate of average annual sediment deposition is .16 acre-feet per square mile.

The volume of sediment deposition in Pouquette Tank is estimated at .013 acre-feet per year. The watershed area above the structure is about .13 square mile. The soils in the watershed consist of shallow rocky, and stony, gravelly loams; and slopes range up to 60 percent and more. The adjusted estimate of average annual sediment deposition is .11 acre-feet per square mile.

### Sunnycove Wash

The drainage area above the Sunnycove damsite is 1.35 square miles. The three major washes in the watershed are well defined and contain a sizeable amount of bedload material.

The sediment yield rate was determined to be 0.14 acre-feet per square mile per year or 0.19 acre-feet per year delivered to the reservoir. With a trap efficiency of 95 percent, the sediment storage requirement is 18.2 acre-feet for the 100-year life of the structure.

Sunset Wash

The drainage area above the proposed structure is 0.60 square mile. The main wash in the watershed is well defined and contains a substantial amount of bedload material.

The sediment yield rate was determined to be 0.135 acre-feet per square mile per year or 0.081 acre-feet per year delivered to the reservoir. With a trap efficiency of 100 percent, the sediment storage requirement is 8.1 acre-feet for the 100-year life of the structure.

## ENGINEERING INVESTIGATIONS

### Maps and Aerial Photographs

Photogrametric topographic maps with a scale of 1" = 80' with a contour interval of two feet were prepared in 1965 by the Army Corps of Engineers for a Flood Plain Information Study. An aerial mosaic of the town was made from a 1966 flight made by the Arizona Highway Department. Land ownership maps were furnished by the town of Wickenburg. Local town personnel assisted in locating underground utilities that were near any planned works of improvement.

### Surveys

Centerline profiles of four potential floodwater retarding structures and five channels were surveyed and used as a basis for computing earth work volumes of embankments and excavation volumes. Topographic maps were prepared on sites where adequate data was not available for design. Cross sections were surveyed for designing outlet channels and for flood plain studies. Detail topographic maps were prepared for potential earth emergency spillway sites.

### Design Criteria

Floodwater Retarding Structures - The basis for design of floodwater retarding structures was to provide a 100-year level of protection to homes and other improvements in the flood plains. The stability of the spillways was given special consideration to ensure safe structures. The Sunset floodwater retarding structure will require a straight inlet reinforced concrete chute spillway because no adequate earth spillway could be located. The Sunnycove floodwater retarding structure will have a 250-foot wide earth emergency spillway located in the left abutment. Both structures will have dry sediment pools. The Sunset principal spillway is designed to outlet into a 12-inch concrete pipeline. The Sunnycove principal spillway outlets into a 12-inch concrete pipeline and junctions with the Sunset pipeline utilizing an 18-inch pipeline to carry all flows to the Hassayampa River. The pipelines were designed to drain the flood pool at the Sunset site in less than ten days and the flood pool of the Sunnycove site in less than 17 days. The SCS computer program FW-HY2-1130F Principal Spillway Routing was used for development of design storms and flood routing through the reservoirs. Both dams are designed for high hazard, class "C," criteria as defined by Engineering Memorandum SCS-27 (Rev.). Soil Conservation Service computer program FW-HY3-1130F Emergency Spillway and Freeboard Routing was used for design storm development, spillway hydraulic computations, and flood routing on the Sunnycove earth spillway. Soil Conservation Service computer program PT-HY11-1130F Emergency Spillway and Freeboard Routing with Reinforced Concrete

Chute Spillway and SAF Basin Design was used for design storm development, spillway hydraulic computations, and flood routing on the Sunset concrete chute spillway. This program also computes the required concrete volumes.

The outlet pipelines were designed on the basis of SCS National Engineering Handbook - Section 5 - Hydraulics.

The earth embankments were designed on the basis of a study of foundation and fill material. The nature and characteristics of these materials were determined by preliminary subsurface investigations and laboratory tests of soil samples.

### Alternate Studies

Alternate locations were considered for the Sunset and Sunnycove structures but were rejected because of unsuitable emergency spillway sites and poor reservoir storage characteristics resulting in overall higher costs. Alternate widths of emergency spillways, elevations of crest of emergency spillways, and type of spillway (earth or concrete chute) were considered to obtain stable spillways at minimum costs.

Alternate studies were made on Sols Wash and Casandro Wash. The structural alternates evaluated were: (1) construct floodwater retarding dams and outlet pipelines, (2) construct floodwater retarding dams and outlet channels, and (3) construct floodwater channels. None of these were feasible because costs exceeded benefits.

A study was made to see if building large waterspreader dikes on the Sols Wash drainage would reduce the peak flows enough to stop flooding on the Sols Wash urban area. This study was made by placing 66,000 linear feet of dikes on the drainage area. These dikes reduced the peak flow by six percent which was not enough to stop flooding damages. The average annual cost of these dikes was \$5,000 compared to an average annual benefit of less than \$500 with the one percent chance storm still causing damage in the urban area. Therefore, it was determined that the flood problem could not be solved by use of dikes.

### Cost Estimates

Land Treatment - Waterspreading Dikes - Cost of the dikes were based on costs incurred for similar treatment in the local Soil Conservation Districts. These costs reflect the current local prices for the operation, services, and materials involved.

Structural Measures - The cost of construction items for the floodwater retarding structures is based on recent contract data for P. L. 566 projects in Arizona and selected U. S. Bureau of Reclamation contract

data in Maricopa County. The Arizona Highway Department's annual publication relating to unit bid costs of highway construction items was also used in preparation of the cost estimate. Estimates of unit costs of outlet pipelines were based in part on price lists furnished by local material suppliers.

Engineering Services - Engineering service costs were derived by the use of Soil Conservation Service criteria. Total engineering service costs are estimated to be twenty percent of the construction costs.

Project Administration - The local project administration cost is estimated to be one percent of the total construction costs. State dam filing fees are an additional administration cost and were computed in accordance with the Arizona Highway Department publication, "*Code Governing Supervision and Control of Dams Revised 1951.*" The P. L. 566 project administration cost is estimated to be ten percent of the total construction costs.

Operation and Maintenance Costs - Estimates for operation and maintenance were computed using percentages of construction costs within the ranges given in Watersheds Memorandum - California No. 6.

Rights-of-Way Costs - Rights-of-way costs were estimated by the town of Wickenburg, based on recent sales of similar properties associated with the construction of city streets. Costs associated with acquiring the lands for right-of-way were computed on a per acre basis. The actual land value costs were increased by twenty percent for all administrative costs associated with acquiring the lands. The twenty percent factor is the value used by the Arizona Highway Department as an estimate of a reasonable value for administrative costs.

Utility Modification Cost - Cost for relocating municipal water lines, sewerage lines, and street paving were based on unit costs furnished by the town of Wickenburg Engineering Office. Costs of relocating underground telephone cables are based on unit costs furnished by the Mountain Bell Telephone Company.

## ECONOMIC INVESTIGATIONS

Separate evaluations were made of the three washes in the Wickenburg Watershed; Sunset-Sunnicove, Casandro, and Sols, due to varied conditions, property values, and economic status of the residents. Historical data on the washes proved insufficient to establish depth-damage figures for the larger events. To establish a base for the larger events, depth-damage data obtained from the September 1970 flood on the Hassayampa River were extrapolated to provide depth-damage relationships for the three evaluated reaches.

Residents along each wash were interviewed to develop historical data as to flood flows, depth of flooding, value of dwellings, and other data. The value of homes within the area ranged from \$5,000 to \$80,000. The value of each home was determined with the assistance of local realtors.

Estimates of damage were established for the 1 percent, 4 percent, 10 percent, 20 percent, and 50 percent events by relating dollar damage to depth of projected flooding for each event by individual home. Average annual damages were established following procedures outlined in the Economic Guide for Watershed Protection and Flood Prevention.

Evaluation of Sols Wash began with interviews of local residents. Historical data on actual flood damage from the August 17, 1971, storm plus additional data from the Hassayampa River flood of September 1970 were the basis of damage analysis estimates. Approximately 45 houses and 40 mobile homes are in the flood plain.

Casandro Wash was analyzed in a manner similar to the analysis of Sunset-Sunnicove and Sols Washes. Sufficient historical data could not be obtained so data from the 1970 Hassayampa River event was used to supplement actual flood damage reports.

An income factor of 1.824 (Gila Water Resource Planning Area - 100-year at 5-1/2 percent) was applied to all residential properties in the watershed to reflect the increased value of property relative to changing levels of income. The price base used was 1972.

Fifteen percent of the direct damages was used to represent the estimated indirect damages occurring as a result of flooding. The indirect damages included emergency patrol measures during times of flooding, temporary evacuation of residents for cleanup and repairs of flood-damaged property, and other emergency measures not evaluated separately as direct floodwater damage.

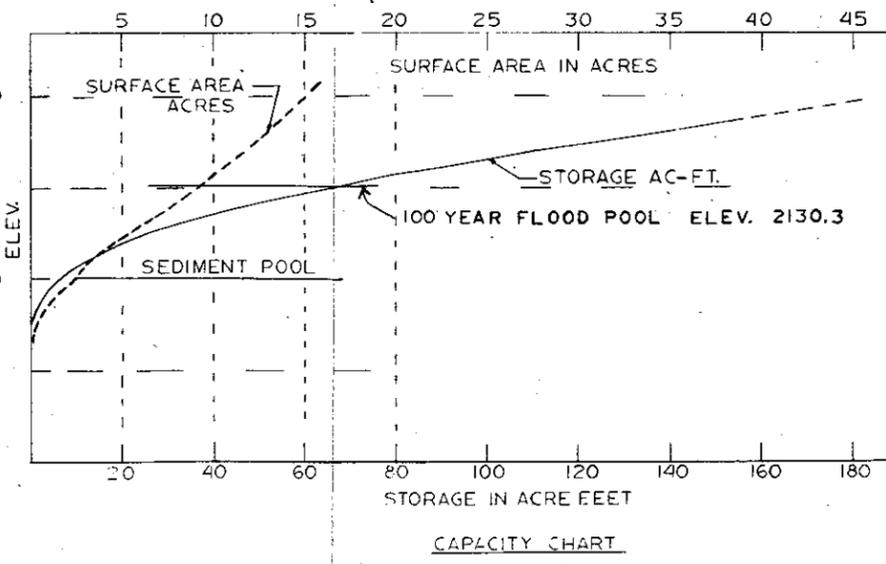
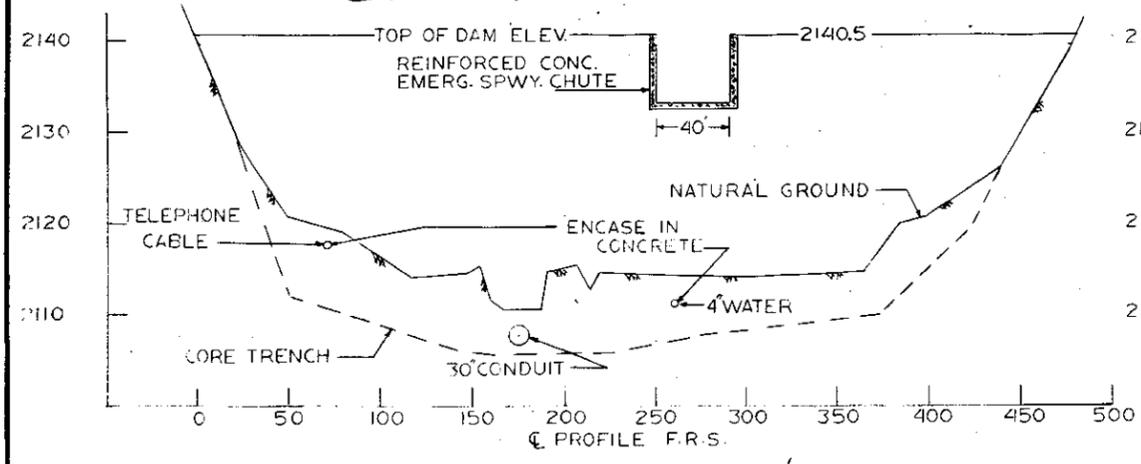
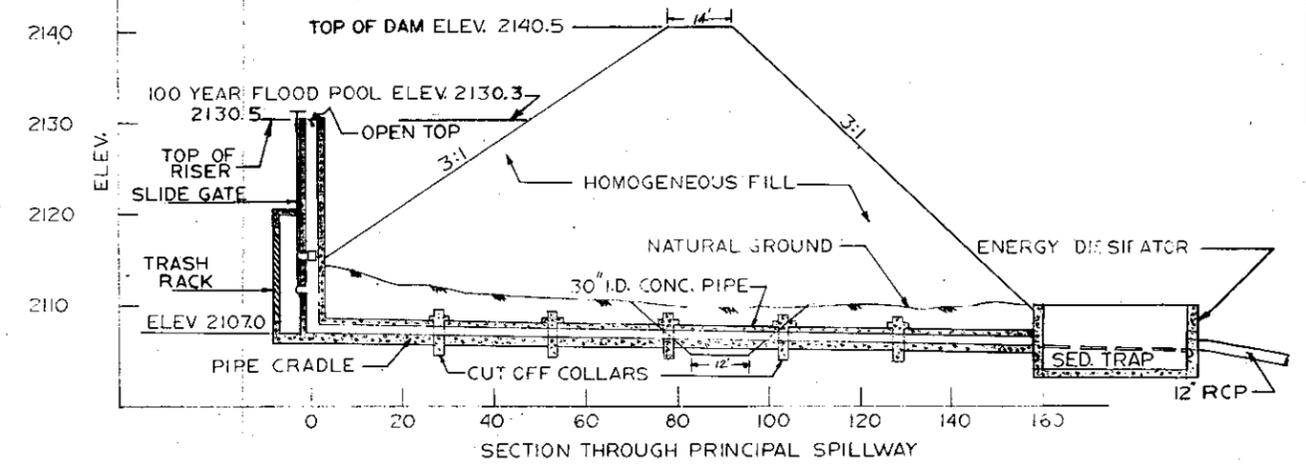
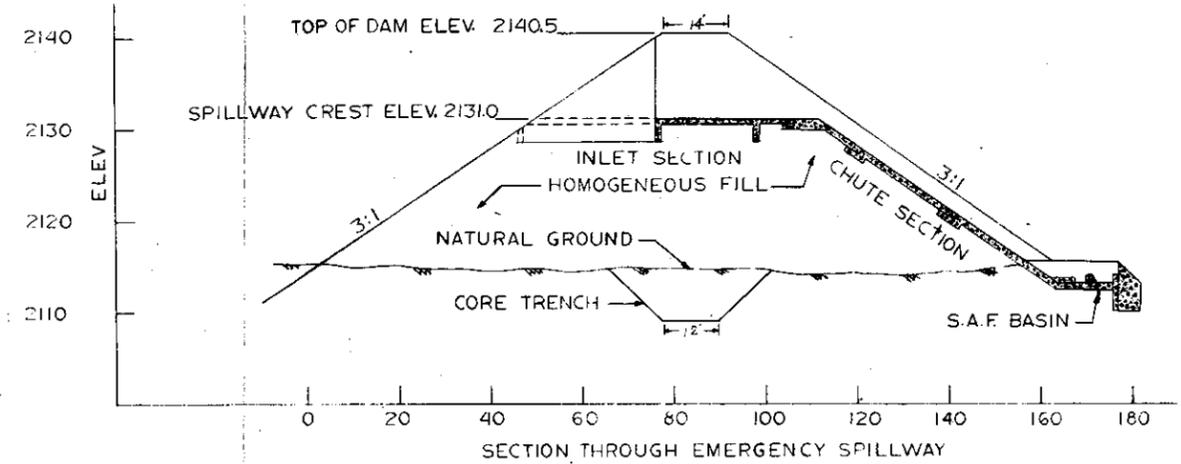
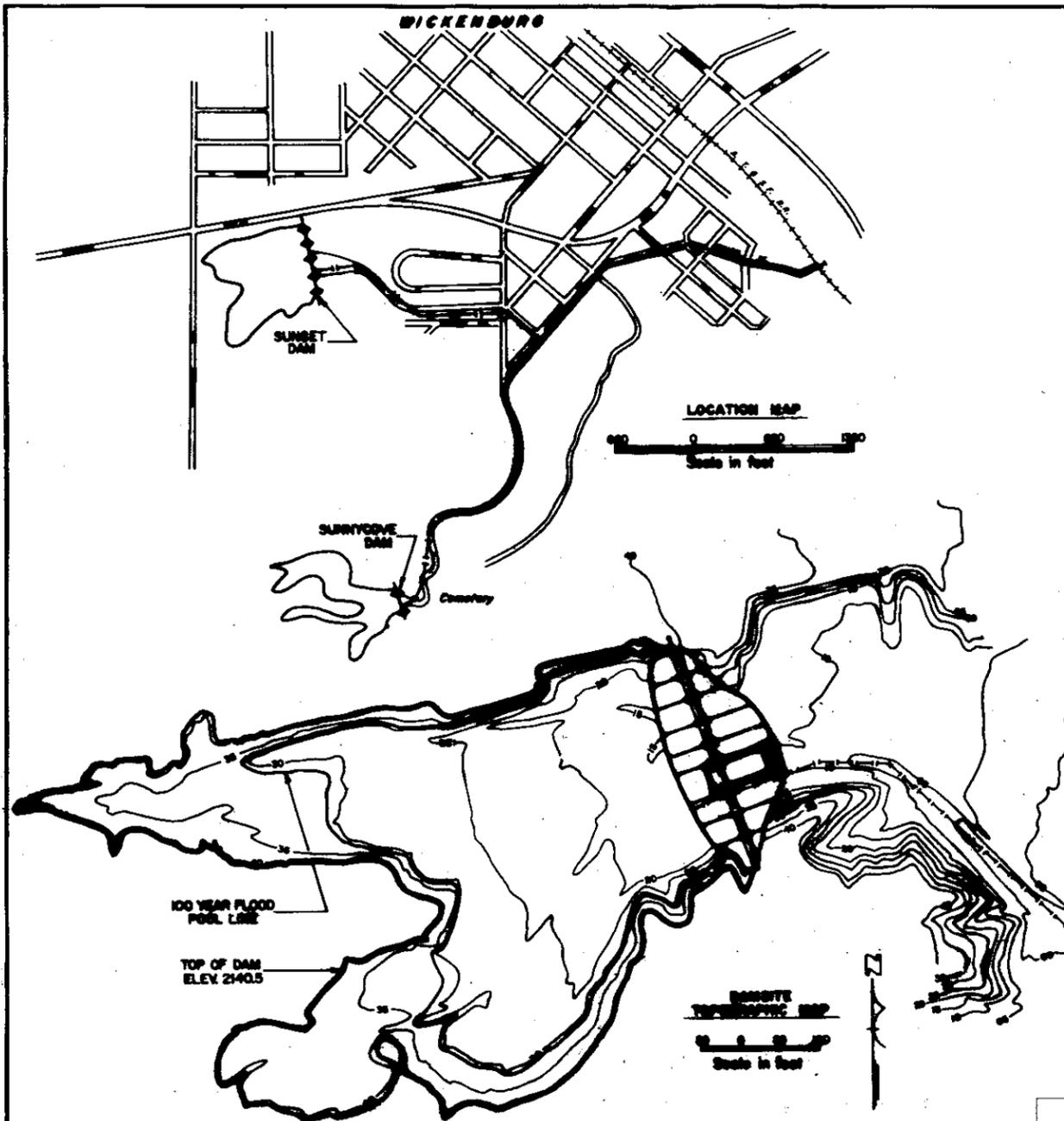
The benefit cost ratio of 1.7 to 1.0 was sufficient to make the Sunset-Sunnycove evaluation unit a feasible project. The average annual benefits for Casandro Wash and Sols Wash were insufficient to justify installation of a project. Benefits and costs were computed assuming a project life of 100 years using the 1972 price base. Secondary benefits were not considered in project evaluation.

## FISH AND WILDLIFE INVESTIGATIONS

Fish and wildlife investigations were conducted by Soil Conservation Service biologists. The Bureau of Sport Fisheries and Wildlife of the United States Department of Interior and the Arizona Game and Fish Department participated in those investigations and cooperatively prepared a report covering the effect of the project on fish and wildlife resources. In part the report states:

*"Wildlife habitat is sparse and the amount of associated resources that would be affected adversely by the project are minimal. Such losses would be insignificant provided that disturbance of adjacent areas is kept to a minimum during construction and that the size of the borrow areas at the dam sites be minimal to preserve the small amount of existing habitat."*

Copies of the complete Fish and Wildlife report may be obtained from the Bureau of Sport Fisheries and Wildlife office at Albuquerque, New Mexico.



**FIGURE I-A**

**WICKENBURG WATERSHED**

**SUNSET DAM**

MARICOPA CO. ARIZONA

**U. S. DEPARTMENT OF AGRICULTURE**

**SOIL CONSERVATION SERVICE**

Designed	Date	Approved by
Drawn <i>Bob Lloyd</i>	1-73	<i>[Signature]</i>
Rev. <i>R.M. Darts</i>	2-74	Title
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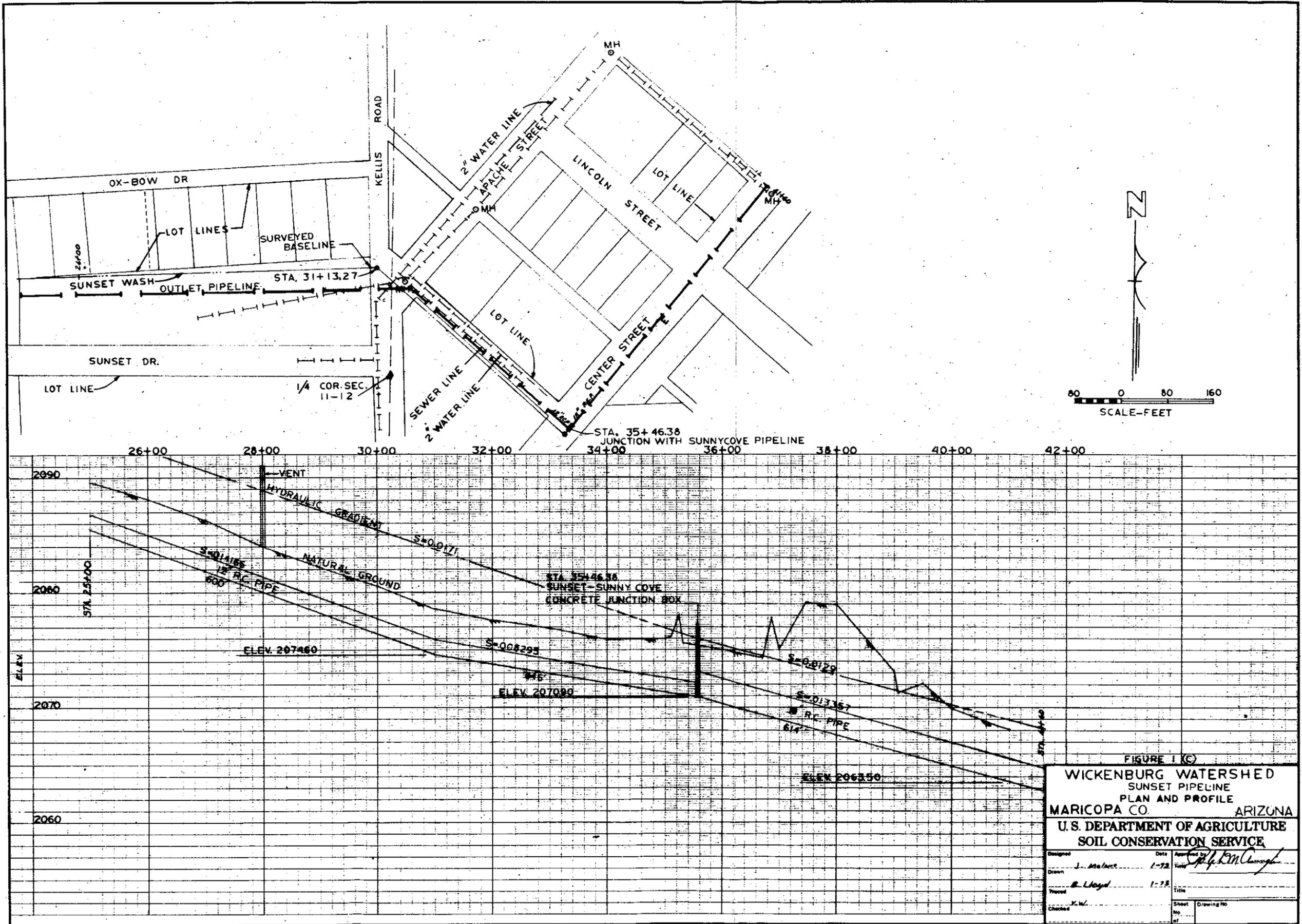


FIGURE 1 (C)

**WICKENBURG WATERSHED  
SUNSET PIPELINE  
PLAN AND PROFILE**

MARICOPA CO. ARIZONA

**U.S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE**

Designed	Date	Approved by	
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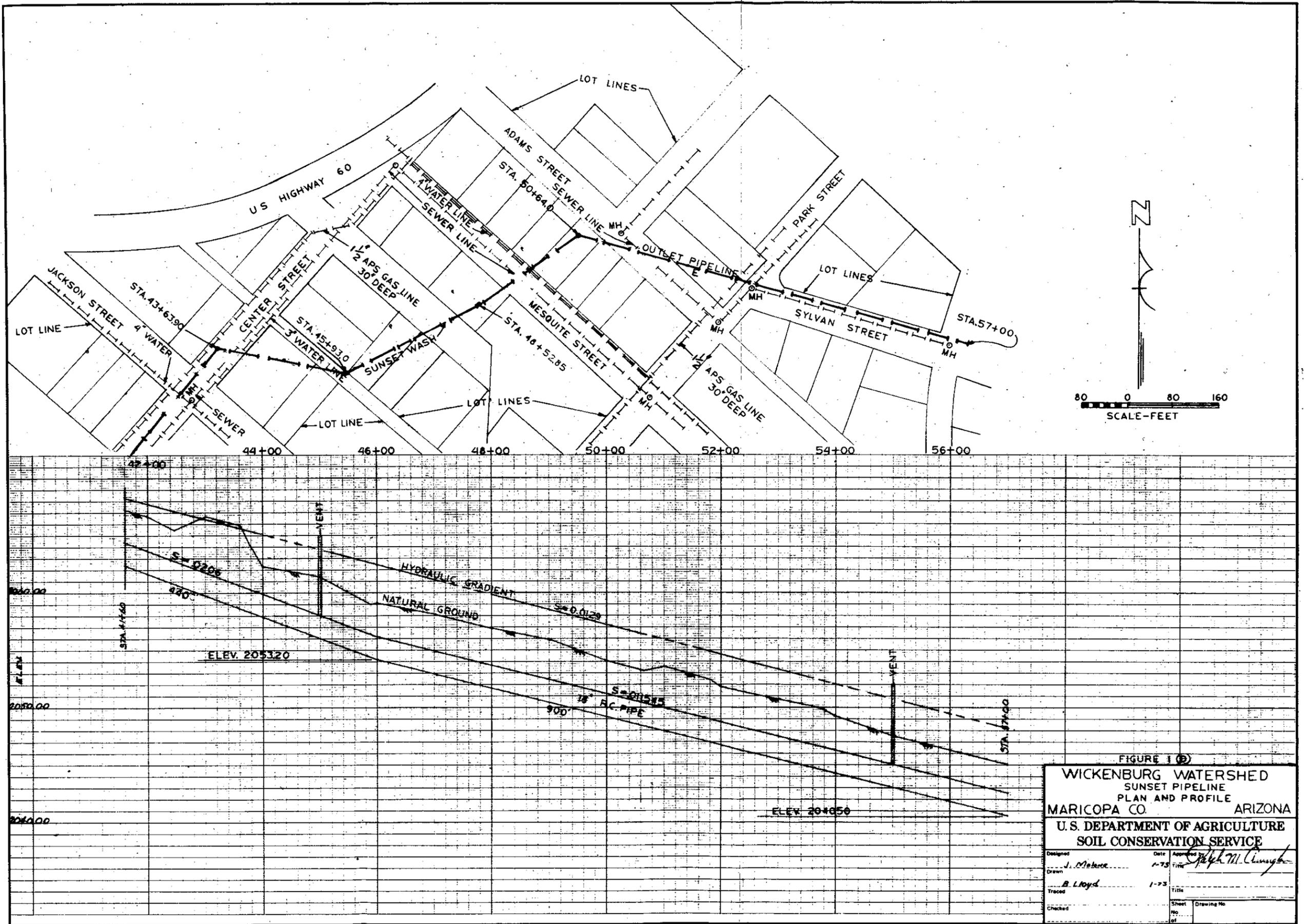


FIGURE 1 (B)

**WICKENBURG WATERSHED  
SUNSET PIPELINE  
PLAN AND PROFILE**

MARICOPA CO. ARIZONA

U. S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE

Designed	Date	Approved	
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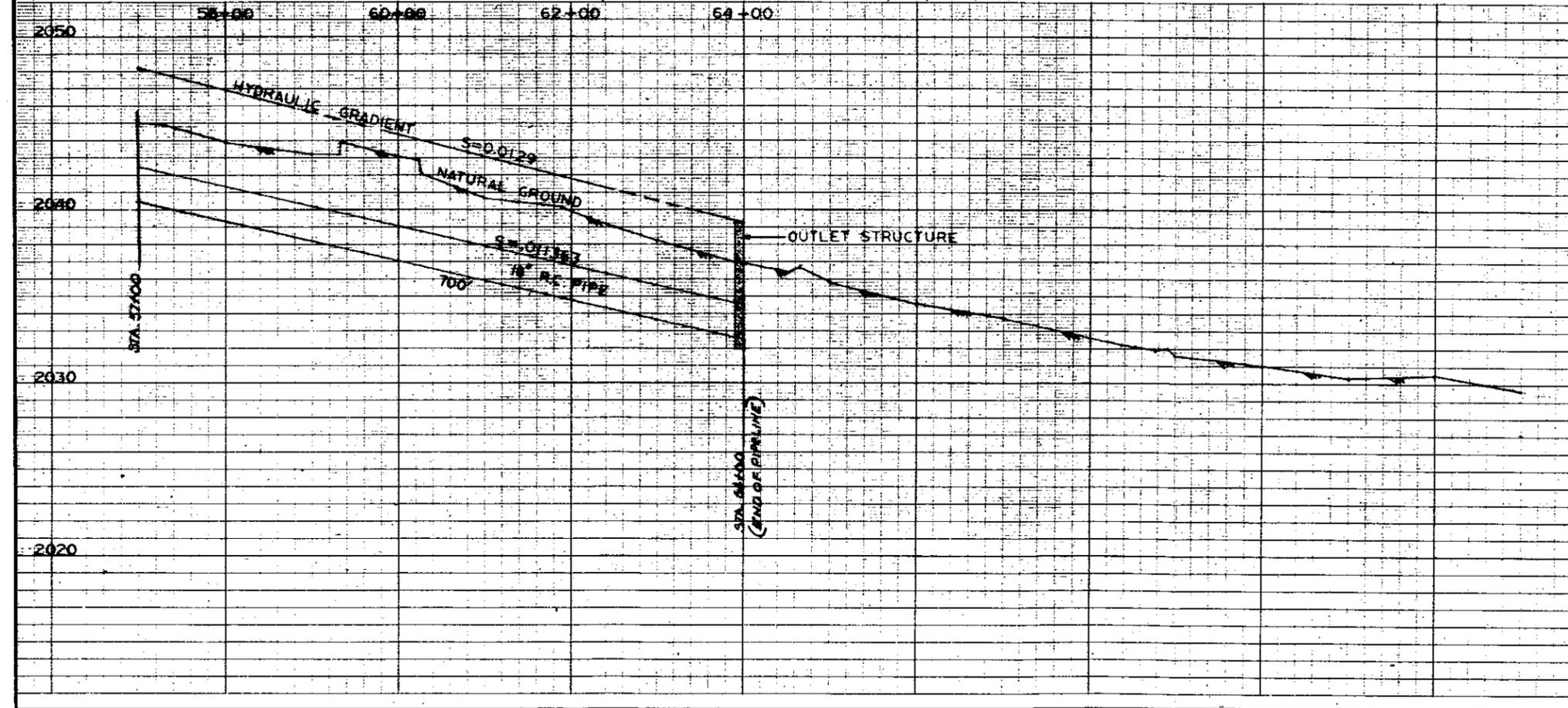
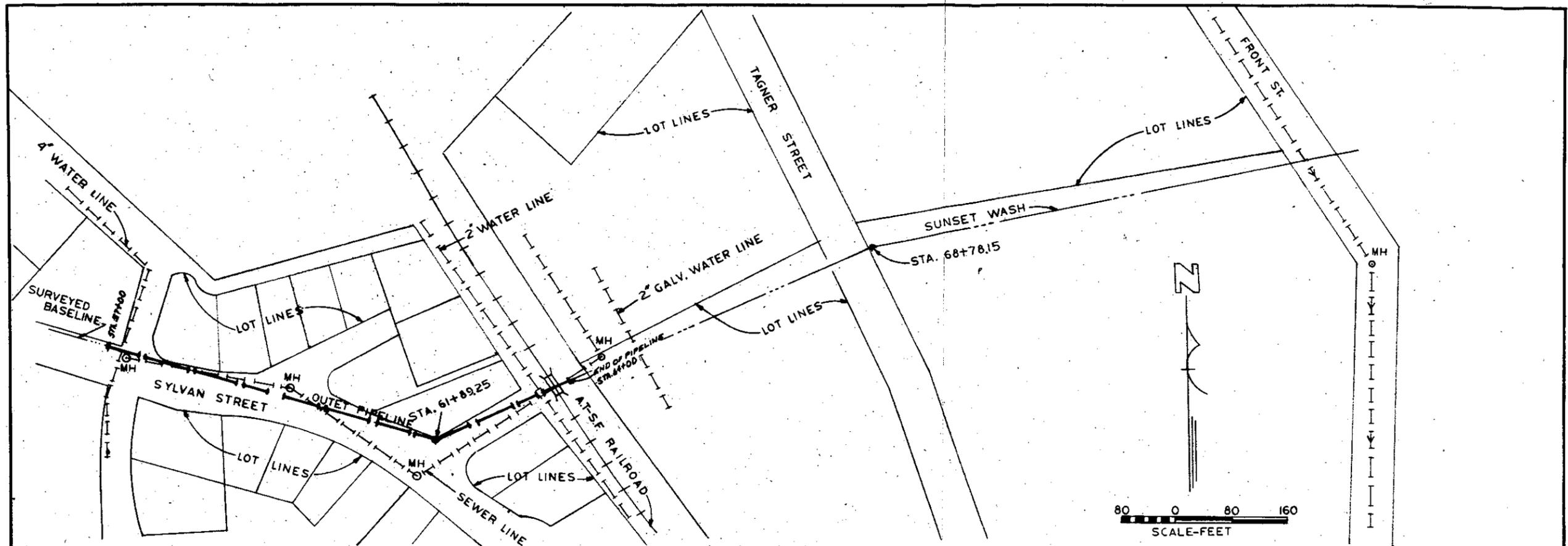


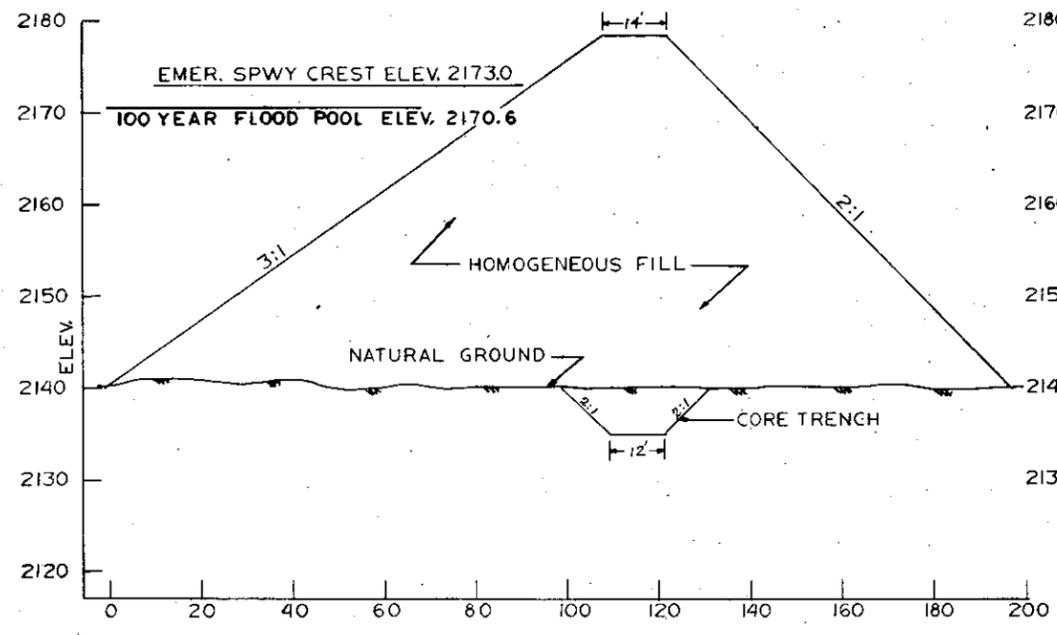
FIGURE 1 (E)

**WICKENBURG WATERSHED  
SUNSET PIPELINE  
PLAN AND PROFILE**

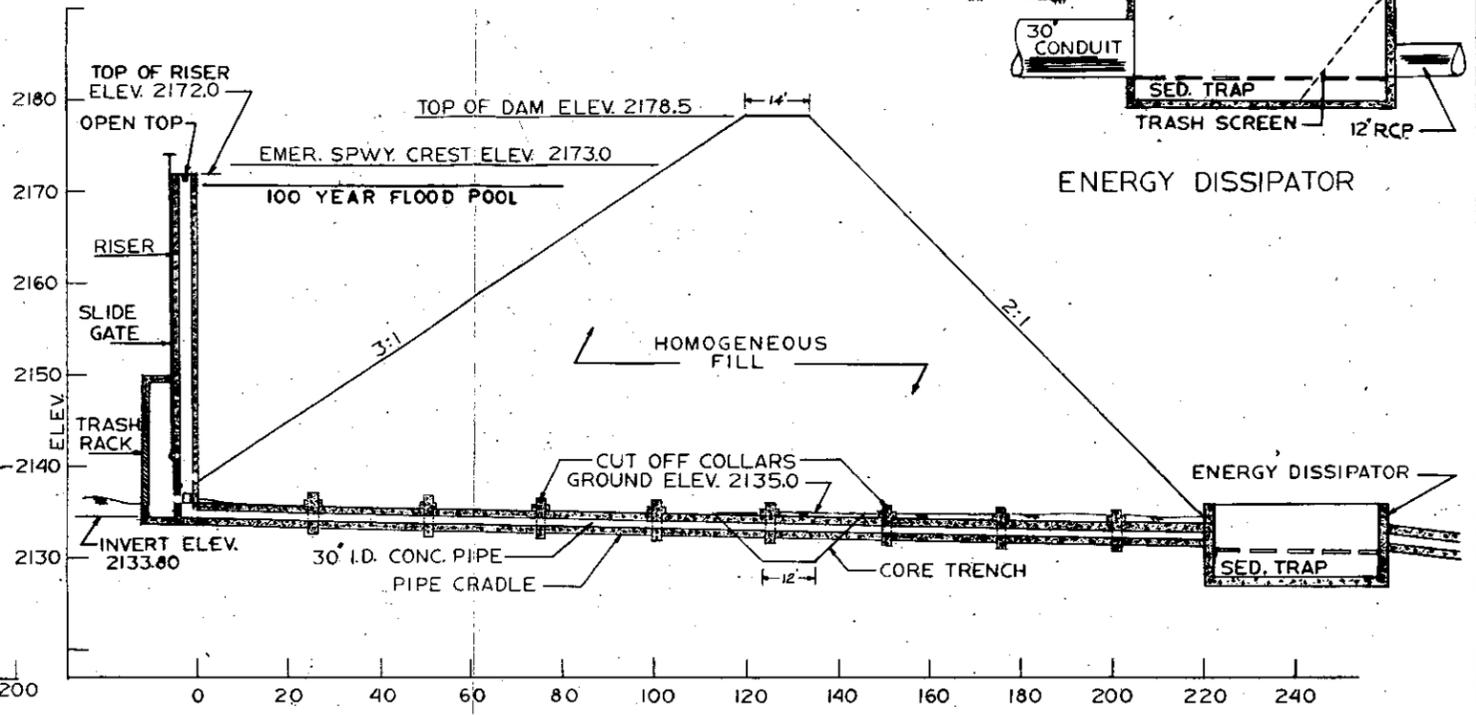
MARICOPA CO ARIZONA

U.S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE

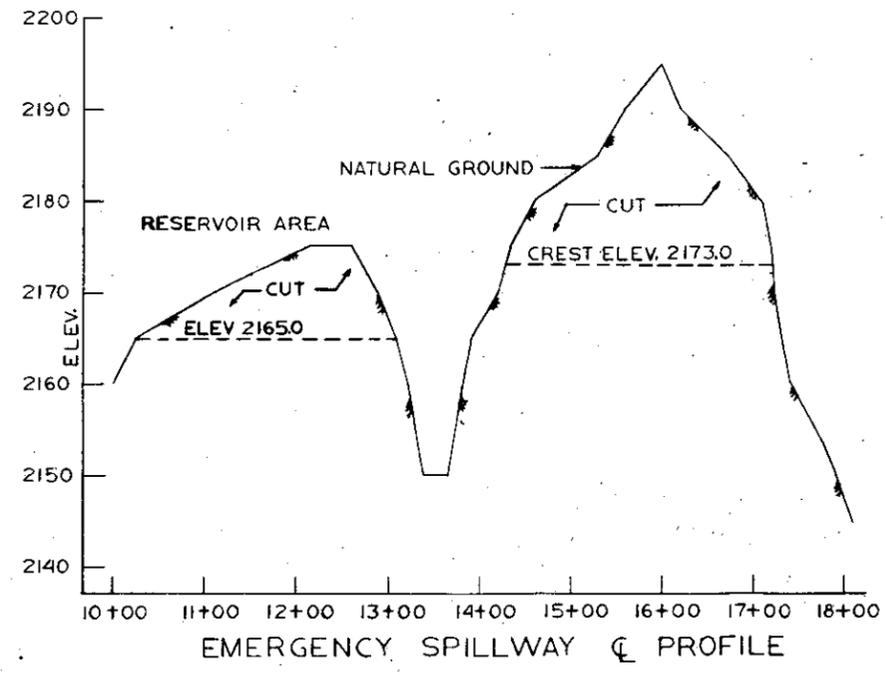
Designed <i>J. Melara</i>	Date 1-73	Approved <i>[Signature]</i>
Drawn <i>B. Lloyd</i>		Title
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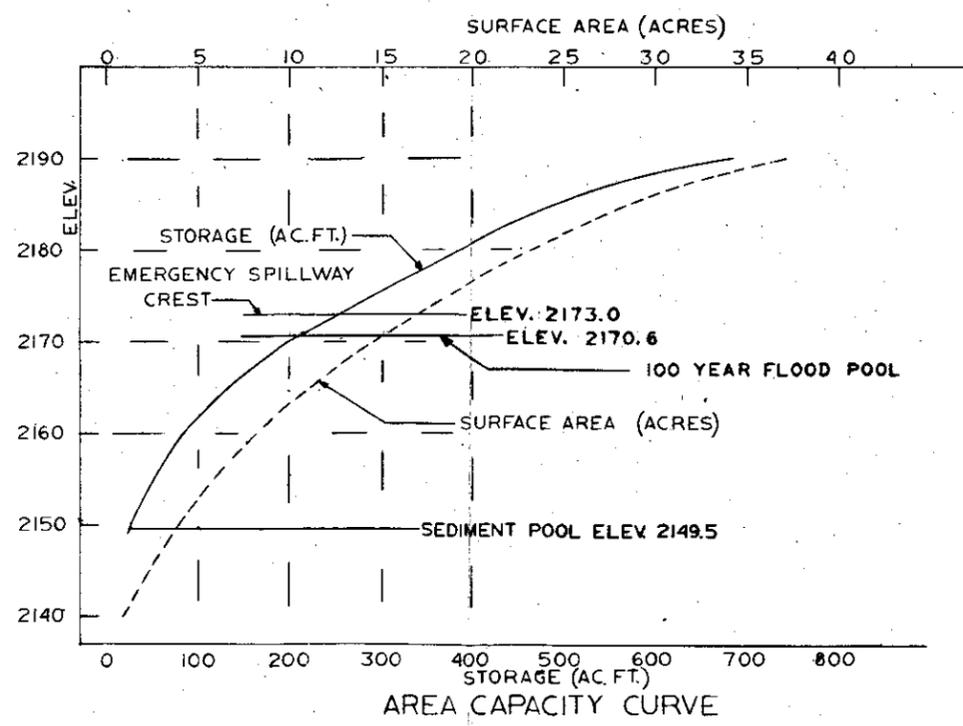
TYPICAL SECTION @ STATION 14+32



SECTION THROUGH PRINCIPAL SPILLWAY



EMERGENCY SPILLWAY C PROFILE



AREA CAPACITY CURVE

FIGURE 2-B  
WICKENBURG WATERSHED  
SUNNYCOVE DAM  
MARICOPA CO. ARIZONA  
U. S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE

Designed: J. Malena	Date: 1-73	Approved by: [Signature]
Drawn: Bob Lloyd	Date: 1-73	Title:
Rev: R.M. Berke	Date: 2-74	Sheet No.:
Checked:		Drawing No.:

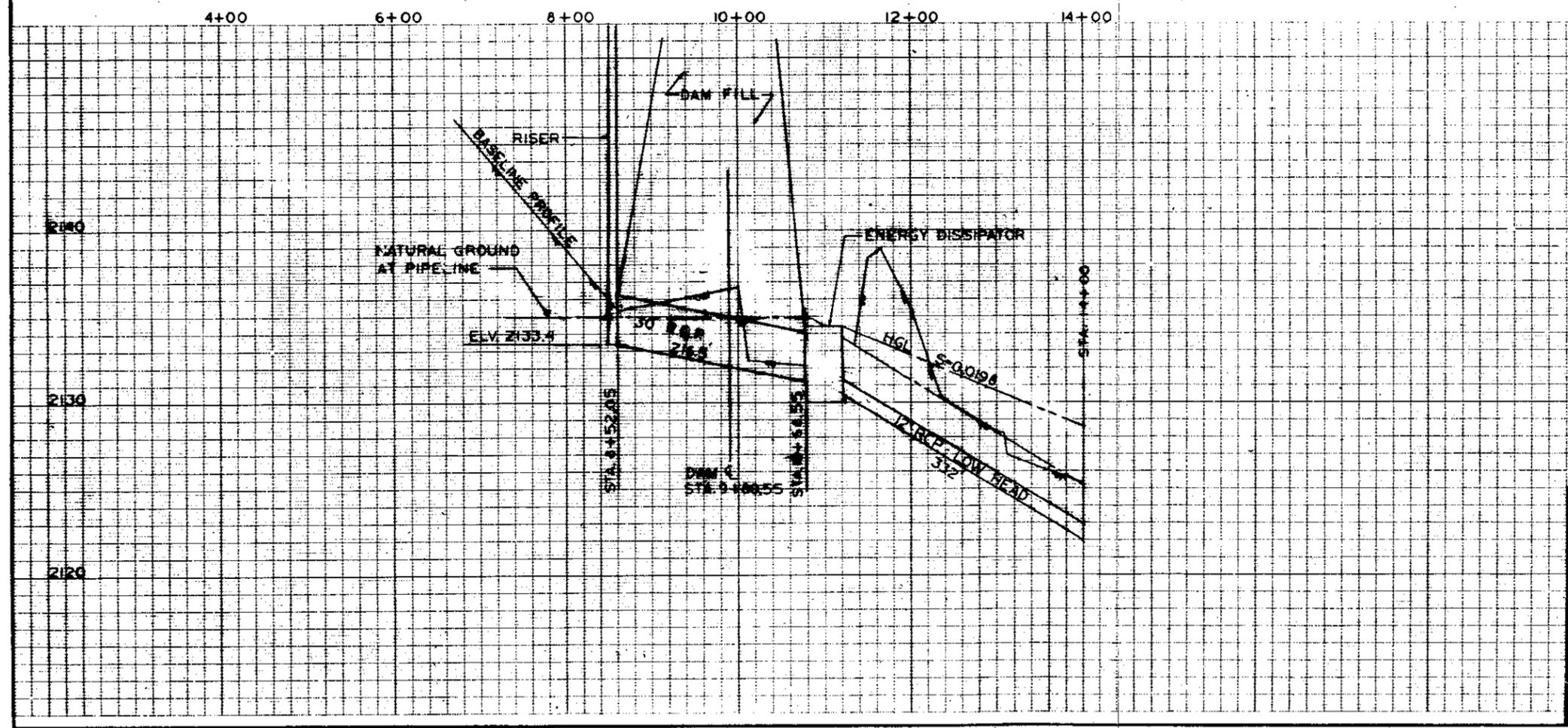
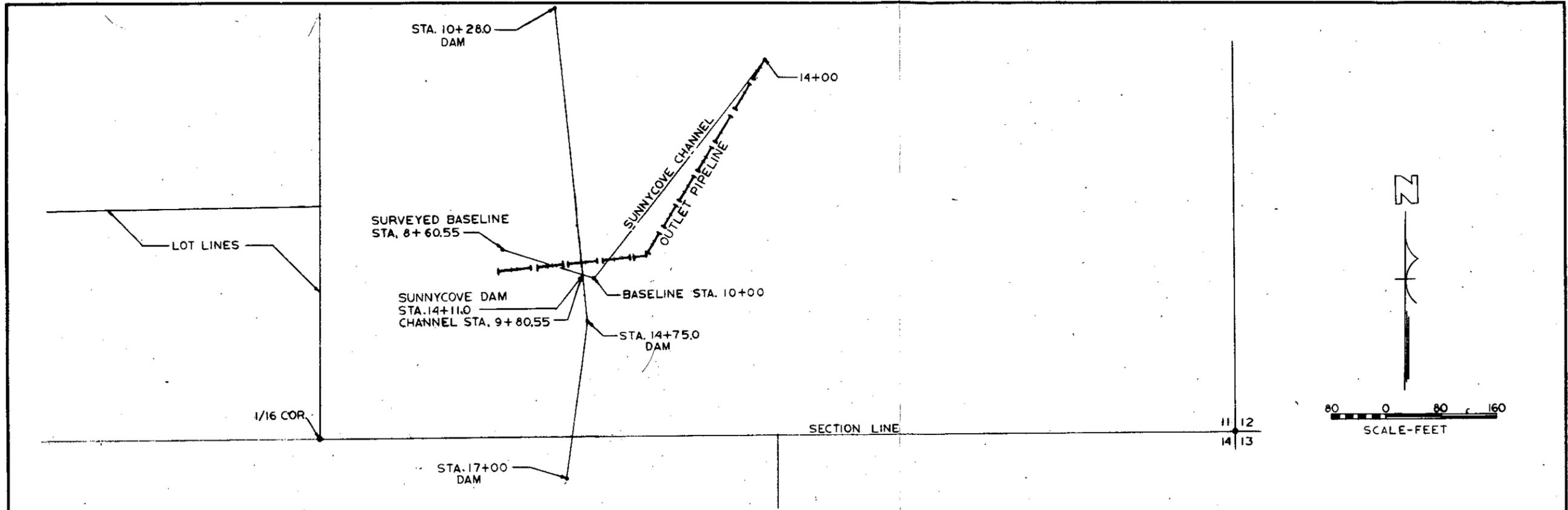


FIGURE 2 (C)

**WICKENBURG WATERSHED**  
SUNNYCOVE PIPELINE  
PLAN AND PROFILE

MARICOPA CO ARIZONA

U. S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE

Designed <i>J. E. Adams</i>	Date <i>1-23</i>	Approved <i>[Signature]</i>	
		Title	
Drawn <i>B. Lloyd</i>	Date <i>1-23</i>		
PEU <i>R. M. Barkels</i>	Date <i>2-78</i>	Title	
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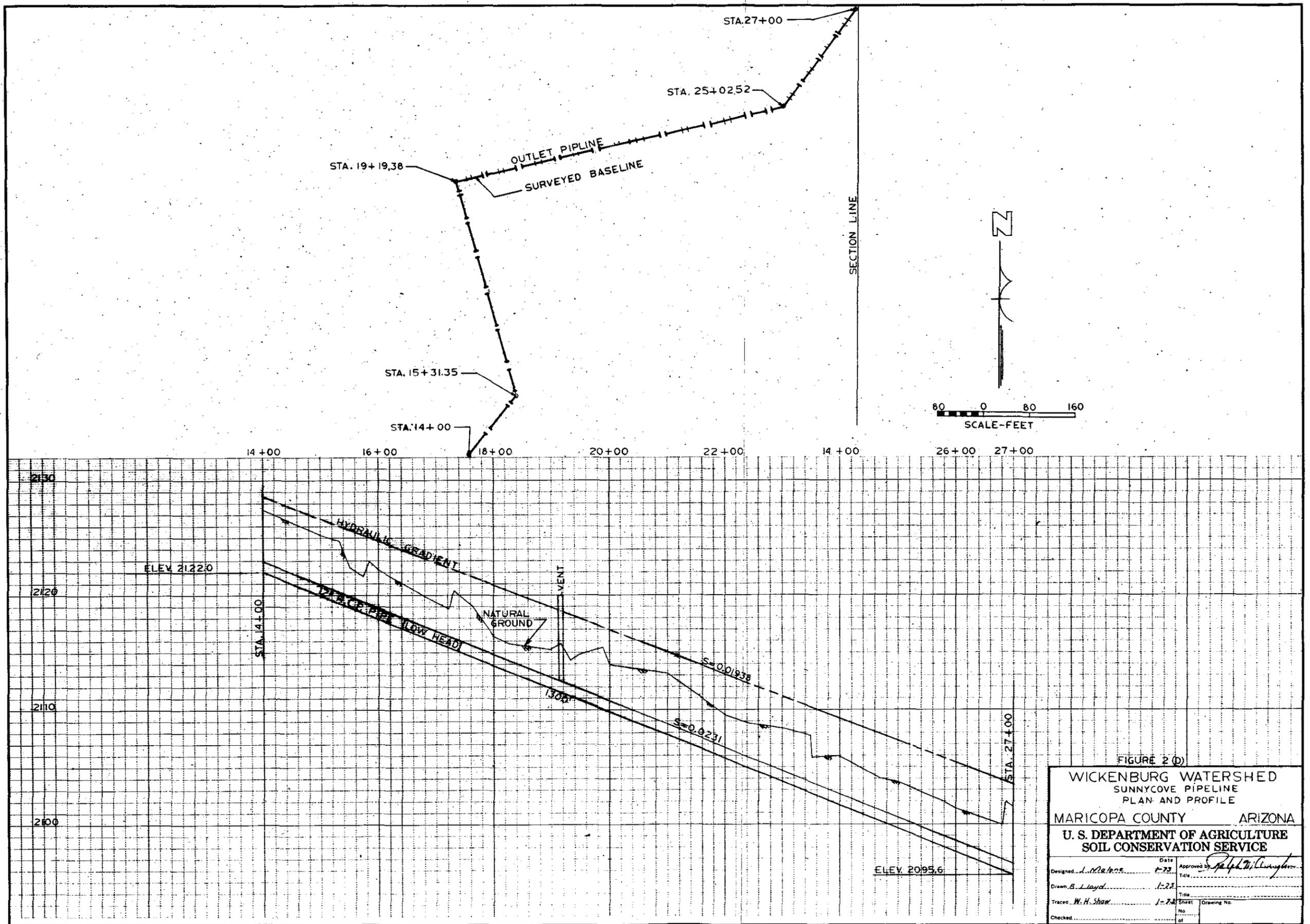


FIGURE 2 (D)

**WICKENBURG WATERSHED  
SUNNYCOVE PIPELINE  
PLAN AND PROFILE**

MARICOPA COUNTY ARIZONA  
U. S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE

Designed <i>L. Malone</i>	Date <i>1-73</i>	Approved by <i>Ralph W. Clingman</i>	Title
Drawn <i>B. L. Lloyd</i>	<i>1-73</i>		
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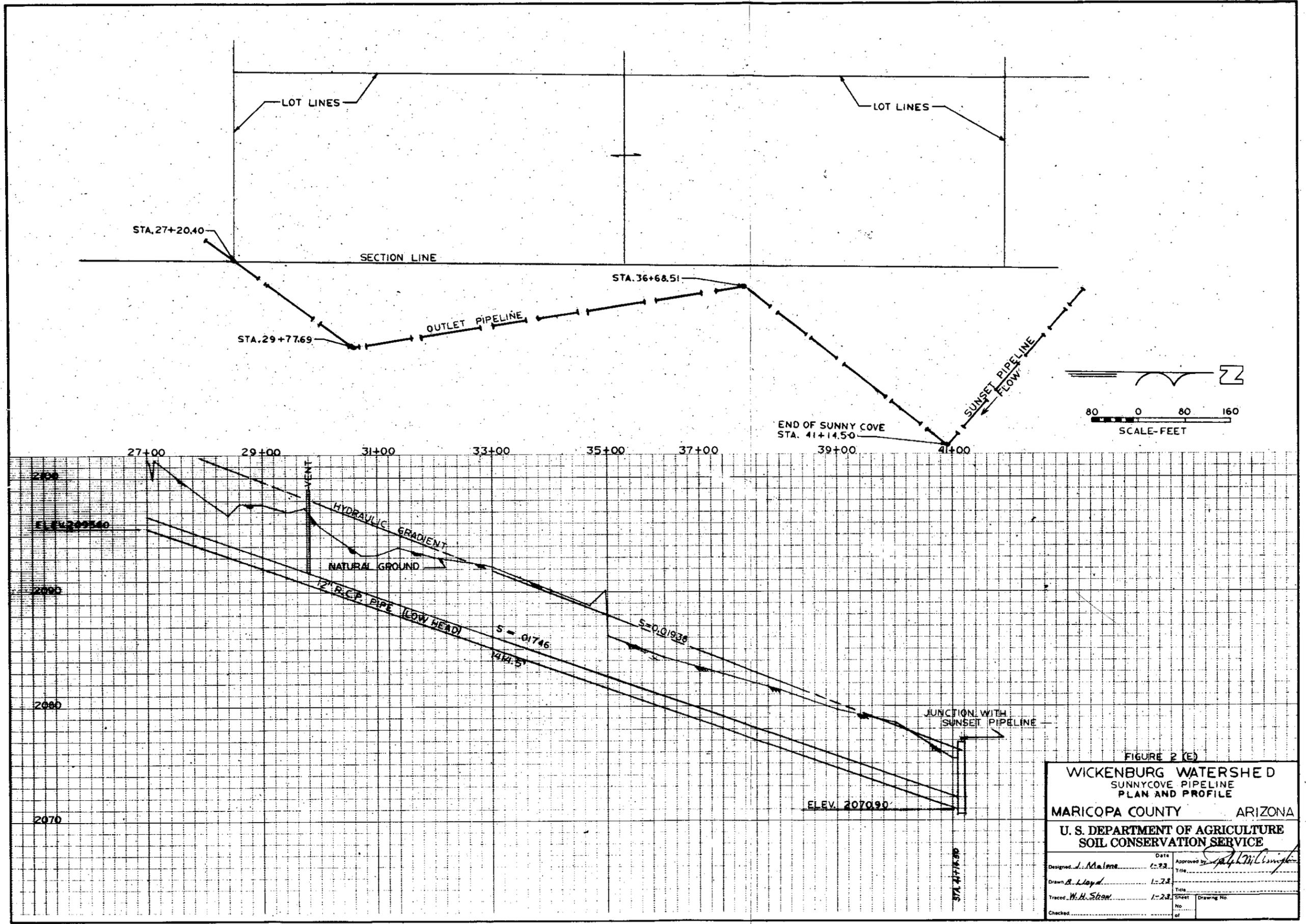
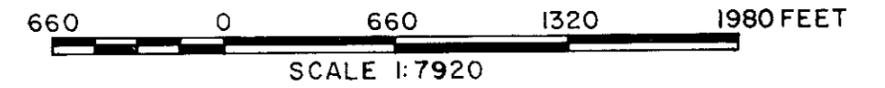


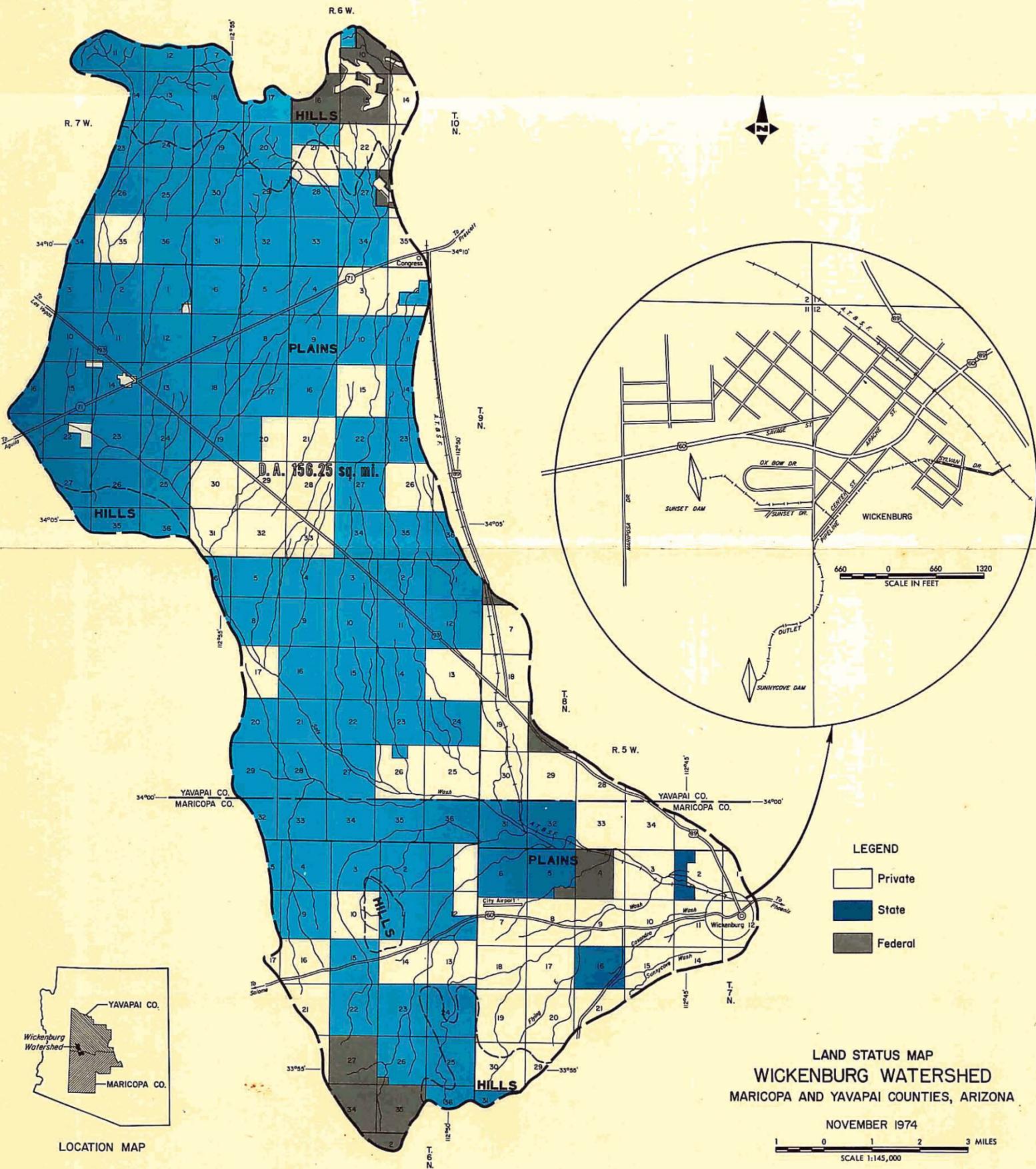
FIGURE 2 (E)

WICKENBURG WATERSHED SUNNYCOVE PIPELINE PLAN AND PROFILE			
MARICOPA COUNTY		ARIZONA	
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE			
Designed <i>J. Malone</i>	Date <i>7-23</i>	Approved by <i>Stephen C. Smith</i>	Title
Drawn <i>B. Lloyd</i>	1-23		
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FIGURE 3  
URBAN FLOOD PLAIN  
WICKENBURG, ARIZONA

- LEGEND
- 100 Year Flood Without Project
  - === 100 Year Flood With Project
  - 100 Year Flood Plain (Hassayampa River, C. of E.)

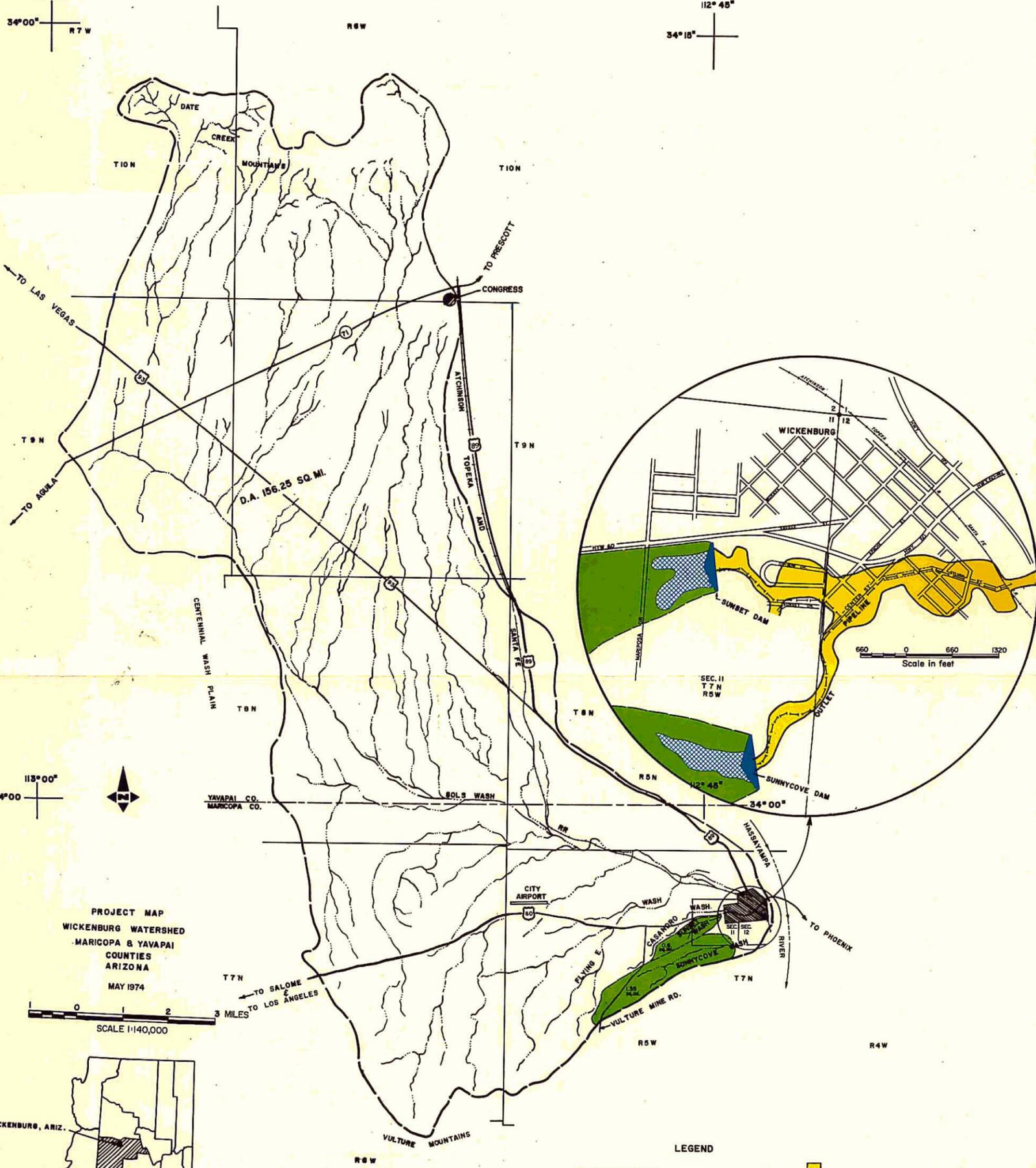




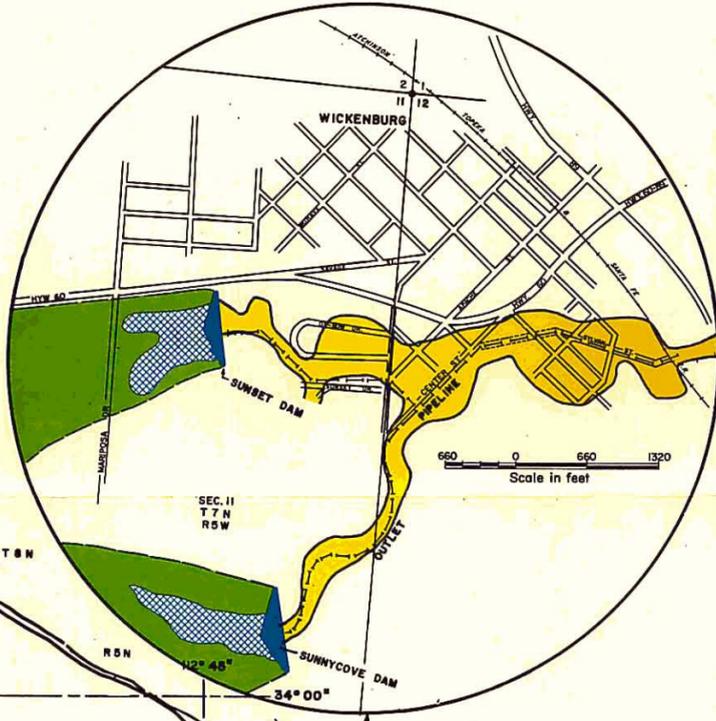
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

113° 00' 34' 00" R 7 W

112° 45' 34' 15"



D.A. 156.25 SQ. MI.



113° 00' 34' 00"



PROJECT MAP  
WICKENBURG WATERSHED  
MARICOPA & YAVAPAI  
COUNTIES  
ARIZONA  
MAY 1974

SCALE 1:140,000



LOCATION MAP

LEGEND

- AREA BENEFITED
- DRAINAGE AREA CONTROLLED
- FLOODWATER RETARDING STRUCTURE
- OUTLET PIPELINE
- CITY



MT-EN-23270

Figure 5