Robinett

United States
Department of
Agriculture

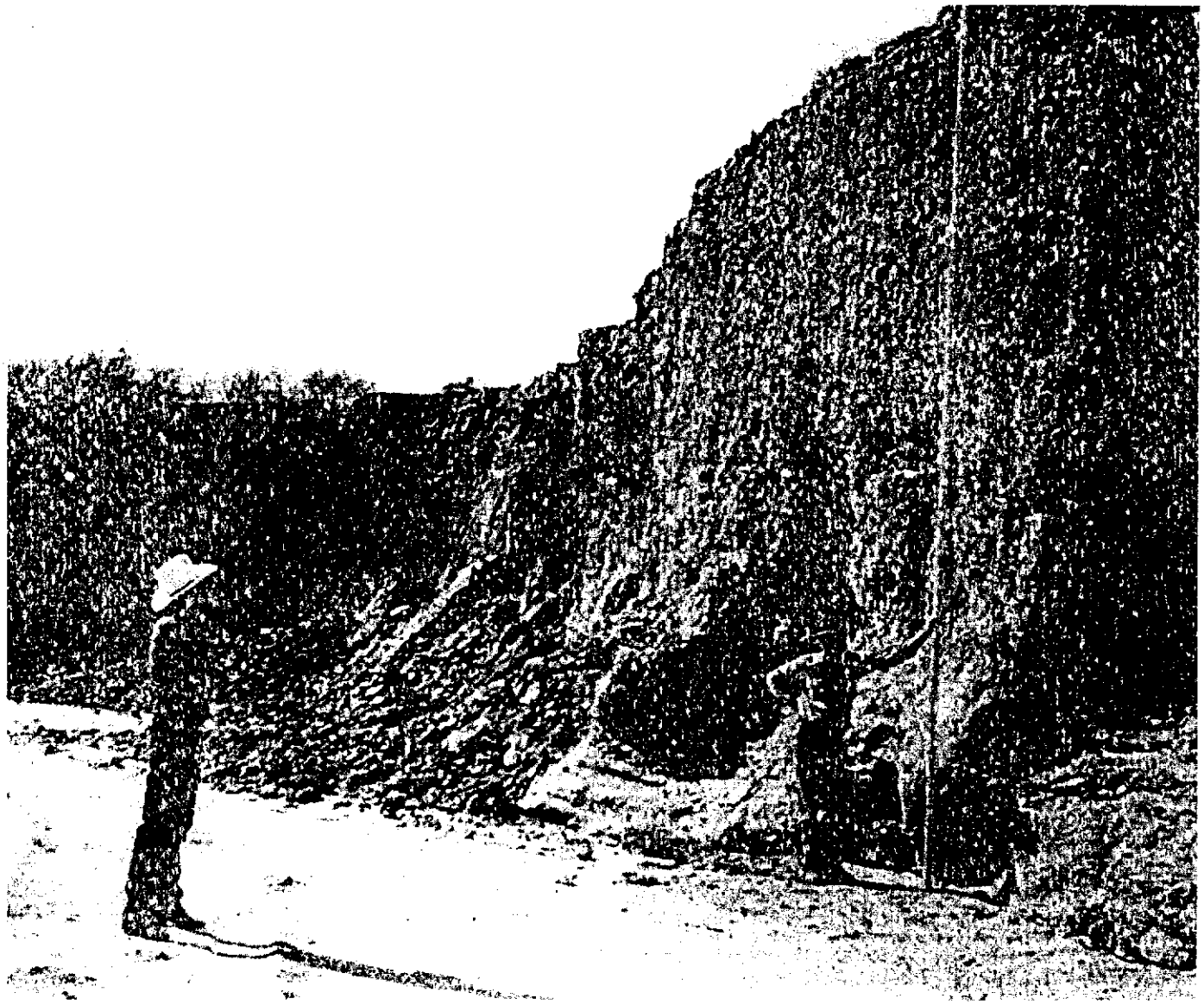
Soil
Conservation
Service

Phoenix
Arizona

BRAWLEY WASH NATURAL RESOURCE RESTORATION PLAN

Pima County, Arizona

June, 1992



We would like to introduce ourselves to you. We are a group of ranch families and citizens committed to stewardship of the Altar Valley where we live and work. A handful of folks began working together as the Altar Valley Conservation Alliance in September 1995. Since then, our group has grown to include most of the Altar Valley ranches, several private citizens from the communities of Robles Junction and Arvaca, and numerous representatives from local, state, and federal government agencies. Our vision follows:

The Altar Valley Conservation has a vision for stewardship of the Altar Valley watershed for the next 50 years. First, open space should be maintained and enhanced, while respecting private property rights. Second, economically productive use of the valley lands, both private and public, should continue. Third, management efforts should accelerate the rate of improvement of the Altar Valley watershed. Fourth, Western cultural values and the historic ranching communities of the Altar Valley watershed should be preserved. These elements of you vision are interwoven-none can be achieved independently, nor can they be achieved without cooperation between all land stewards within the Valley. This vision will guide Alliance projects and efforts to work cooperatively with public and state land managers and others who have a take in the future of the Altar Valley watershed.

Currently, we are working on a watershed resource assessment project, funded by the State of Arizona, Water Protection Fund. We are compiling historical and current stewardship data for the Altar Valley watershed and will use this information to create an action plan for future stewardship projects. We have developed and continue to maintain a prescribed natural fire management map for the watershed, and have made significant progress on transferring this data into a Geological Information System database. We support each other and share information about other situations as the need arises. In general, we strongly believe that ranching and conservation are ideal partners. We strive to act upon our beliefs and seek every opportunity to spread the word about the positive role ranching plays in preserving open space and habitat, maintaining open lands for public use and economic activity, and building healthy productive communities.

NATURAL RESOURCE RESTORATION PLAN FOR THE BRAWLEY WASH WATERSHED

Pima County, Arizona

PREPARED BY
USDA, SOIL CONSERVATION SERVICE
PROGRAM PLANNING STAFF
Phoenix, Arizona

IN COOPERATION WITH
PIMA NATURAL RESOURCE CONSERVATION DISTRICT

JUNE, 1992

LIST OF PREPARERS

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A special thanks to the many employees of the groups listed in the report that supported the study efforts and provided information.

Under coordination of the **USDA River Basin Coordinating Committee**:

Donald W. Gohmert, Soil Conservation Service, Chairman
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BRAWLEY WASH

NATURAL RESOURCE RESTORATION PLAN

SUMMARY

Project Name: Brawley Wash Natural Resource Restoration Plan
County: Pima
State: Arizona
Sponsor: Pima Natural resource Conservation District

Recommendation:

A "demonstration" grade control structure with vegetative management practices is recommended for Brawley Wash. The following evaluations should be completed for the demonstration project in order to provide site specific data that will aid in final project planning: 1) efficiency in trapping sediment, 2) length of floodplain effectively restored, 3) best vegetation and management practices, 4) floodplain flow characteristics, 5) surface and ground water quality impacts, and 6) groundwater level changes. Based on the data collected, a series of future grade control structures can be planned. Range management practices, which are being installed under on-going USDA technical and cost share programs, should also be incorporated into this project plan.

Resource Information:

Size of watershed 506,880 acres
Land use -

Rangeland	76%
Wildlife Refuge	17%
Other	7%

Land ownership -

State of Arizona	53%
Private	17%
USFWS	16%
BLM & USFS	9%
Indian Trust	5%

Number of ranch units - 25
Ranch sizes - 640 to 50,000 acres
Endangered Species -
Masked bobwhite (Colinus virginianus ridgewayi)
Tumamoc globeberry (Tumamoca macdougallii)
Cultural Resources - small fragments of pottery, stone flakes, and ground stone pieces appear to be scattered along the whole length of Brawley Wash.

Problem Identification:

The primary problems which have been identified are:

1 - Stream bank erosion and associated loss of riparian and range habitat along the Brawley Wash.
2 - Sheet, rill, and gully erosion and associated damages to rangeland and improvements.
3 - Sedimentation effects on downstream water quality, farmland, and county and state road crossings.
4 - Flash flooding and associated damages to roads, farmland and local communities.
5 -Loss of ground water recharge due to accelerated, concentrated flows within the incised wash.

Project Purpose:

As requested by the Pima NRCD and recognized in the scoping process, the main objective of this study is to develop alternatives that will control the overall erosion which is adversely impacting the area's natural resources, land values, and structural features.

Alternatives:

The formulation of alternatives for this project was guided by the concept of reestablishing the base level of the area's historic floodplain.

Using this concept to guide the planning process, the following alternatives were developed to solve the existing problems:

1. No action.
2. Grade control structures.
3. Grade control structures and vegetative management.

Principal Project measures and project costs (for a typical site):

	Baffle Chute Option	Stair-Stepped Option
Grade control measures	$1,000,000	$700,000
Vegetative measures	$ 110,000	$110,000
Proj. Adm. & Eng.;	$ 250,000	$180,000
Landrights	not estimated	
TOTAL	$1,360,000	$990,000
OM&R (Life expectancy 100yr.)		$1,000/yr.

Impacts:

Reestablish over 75 acres of incised land per structure. Increase flowage area (average 550 acres/structure). Increase flow duration (decrease flow velocities as much as 15 fps) and potential for ground water recharge, and reduce peak discharge by as much as 6000 cfs/structure. Reduce or eliminate seven acres of average annual land loss and 100 acre-feet of sediment per year. Decrease recurring damage to fences, structures, and state and county roadways. Improve esthetic values. Restore riparian vegetation. Improve wildlife habitat. Increase production of game species. Increase forage produced by 8 to 10 times the average upland range site.

INTRODUCTION

AUTHORIZATION

The Brawley Wash Project is a Cooperative River Basin Study initiated at the request of and sponsored by the Pima Natural Resource Conservation District (NRCD) with technical assistance provided by the U.S. Department of Agriculture, Soil Conservation Service (SCS).

The U.S. Department of Agriculture is authorized, under Section 6 of Public Law 566, 83d Congress, 68 Stat. 666 (P.L. 83-566), as amended, to cooperate with state and local governments and with other federal agencies, to make investigations and surveys of watersheds, rivers, and other waterways as a basis for the development of coordinated programs.

This natural resource plan was prepared pursuant to P.L. 83-566 to meet the specific needs of the Pima NRCD.

PURPOSE

The Pima NRCD has recognized the need to evaluate the significant erosion which has incised Brawley Wash and its tributaries. Alternatives which would help restore the floodplain to its original condition will reduce soil erosion, sedimentation, and flash flooding, improve ground water supply, and restore the range, riparian, and wildlife habitats.

The study is needed to help the NRCD identify the area's problems and assess the physical, economic, and environmental aspects of treatment alternatives. The report will be used by the NRCD and other supporting agencies and groups to help justify a project need and establish funding for project implementation.

PARTICIPATION

The Pima NRCD (also referred to as the Sponsor) provided leadership in coordinating the study through public meetings and reviews. In September 1989, a scoping meeting was held to determine significant issues, planning objectives and local participation. Seventeen concerns and planning objectives were listed and local participation identified to coordinate seven specific items of work. Fifteen scoping response sheets were returned showing individual concerns, in the order of importance, for the area's resource problems.

In April 1990, the Pima NRCD sponsored a project-area tour which was attended by approximately 60 people and covered by the local news media. Each month, the Sponsor scheduled time for project discussion during regular board meetings.

Others supporting the study efforts and providing technical assistance or information included:

1. Arizona Department of Water Resources - Water rights and permits information.
2. U.S. Fish and Wildlife Service - Reconnaissance flight over the watershed.
3. City of Tucson - Results of hydrogeologic investigations for the proposed Brawley Wash surface water recharge site.
4. Pima County Flood Control District - Hydrologic and flood damage information.
5. Arizona Department of Environmental Quality - Water quality and EPA program information.
6. U.S. Bureau of Land Management - Tour and information of the San Simon project near Safford, Arizona (a successful rehabilitation project of an incised drainage).
7. Tohono O'odham Indian Nation, Sierra Club, Pima Association of Governments, Private Landowners, Arizona-Sonora Field School, Cooperative Extension Service, Arizona Game and Fish, Arizona State Land Department, University of Arizona, U.S. Forest Service, Pima County Parks & Recreation, Southern Arizona Water

Resources Association, Town of Marana, Bureau of Reclamation - General project area information.

The expertise and data provided by these groups were invaluable in improving our understanding of the problems and opportunities in the project area.

The SCS provided technical assistance, maintained contacts and provided progress reports to keep local people informed.

PROJECT SETTING

STUDY AREA

The Brawley Wash Watershed is located in Altar Valley in Pima County. It is situated in southern Arizona approximately 20 miles west of Tucson. The 506,880-acre study area is defined by the watershed boundary south of Three Points (Refer to River Basin Vicinity Map).

Altar Valley is a broad, north trending basin bounded on the east and west by rugged mountains. The local topography ranges from steep ridges with elevations up to 7,740 feet, descending to lower valley terraces with elevations ranging from 2,500 to 3,600 feet.

DEMOGRAPHY

The total population in Pima County was 666,880 according to the 1990 census of population. The population of the project area does not exceed several thousand. The towns within the study area include Sasabe, Three Points, and Arivaca. Sasabe's estimated population is 50. Sasabe is a small settlement with a post office, school, general store, bakery, cantina, church and about 20 houses. There is some employment in Sasabe from the importation of adobe bricks from the adjacent village of Sasabe, Sonora, Mexico. Three Points is smaller and Arivaca is about the same size as Sasabe. The economic base for these three towns is ranching.

According to the 1990 census, the population of the project area is approximately 96 percent white, 1 percent Indian, and 3 percent other. The number of people of Hispanic heritage totals about 26 percent of the general population.

Total employment in Pima County for June 1983 was 225,300. The service sector provided the largest source of employment -- 20 percent. Both wholesale and retail trade and government employment were next at 19 percent each. Agriculture provides 14 percent of the county's employment.
Project area residents not locally employed commute to the Tucson Metropolitan area for employment opportunities.

The median family income for Pima County was $23,975 in 1982, as compared to $24,000 for the state of Arizona. Tucson had a lower median income with $21,950. The average annual wage payments to employees in the state was $16,000 in 1982, with employees in the agriculture and forestry industries receiving an average of $10,277.

CLIMATE

The climate of the area is semi-arid, characterized by low precipitation, low humidity, and high summer temperatures. In Altar Valley, rainfall varies from approximately 12 inches in the central valley to 20 inches on some of the higher slopes. There are typically two rainy seasons; summer rainfall which occurs usually in local torrential convection showers, often concentrated over mountain masses, and winter rainfall which is usually slow, steady, and of several days duration. Precipitation in the winter sometimes occurs as snow in the mountains.

The valley's desert temperatures have extreme daily and monthly ranges. Daily variations of 30 to 50 degrees or more result from the low degree of cloudiness and the arid characteristic of the desert climate. Maximums of 100 to 110 degrees are common in the summer while minimum winter

temperatures generally do not fall below 20 to 25 degrees.

SOILS

General soils information for the Brawley Wash Study Area:

WARM, ARID SOILS ON FLOODPLAINS AND STREAM TERRACES

The soils in this group are formed in mixed, stratified alluvium and are very deep and well drained to excessively drained. Elevation is 2,000 to 4,600 feet. Average annual precipitation is 10 to 16 inches. Slopes range from 0 to 3 percent with vertical scarps near the channels. This group makes up about 8 percent of the watershed and is used mainly for rangeland.

WARM, ARID SOILS ON FAN TERRACES, HILLS AND VALLEY FLOORS

The soils in this group are formed in mixed alluvium and are very shallow to deep and well drained. Elevation is 2,200 to 3,600 feet. Average annual precipitation is 10 to 13 inches. Slopes range from 0 to 35 percent. This group makes up about 24 percent of the watershed and is used mainly for rangeland.

WARM, SEMI-ARID SOILS ON FAN TERRACES AND HILLS

The soils in this group are formed in mixed alluvium and colluvium and are very shallow to very deep and well drained. Elevation is 3,100 to 5,200 feet. Average annual precipitation is 12 to 16 inches. Slopes range from 1 to 50 percent. This group makes up about 32 percent of the watershed and is used for rangeland.

WARM, ARID AND SEMI-ARID SOILS ON PEDIMENTS, HILLS AND MOUNTAINS

The soils in this group are formed in mixed alluvium and colluvium and are very shallow to shallow and well drained. Elevation is 2,200 to 5,500 feet. Average annual precipitation is 10 to 16 inches. Slopes range from 1 to 65 percent. This group makes up about 31 percent of the watershed and is used mainly for rangeland and some recreation.

COOL AND COLD, SUBHUMID SOILS ON HILLS AND MOUNTAINS

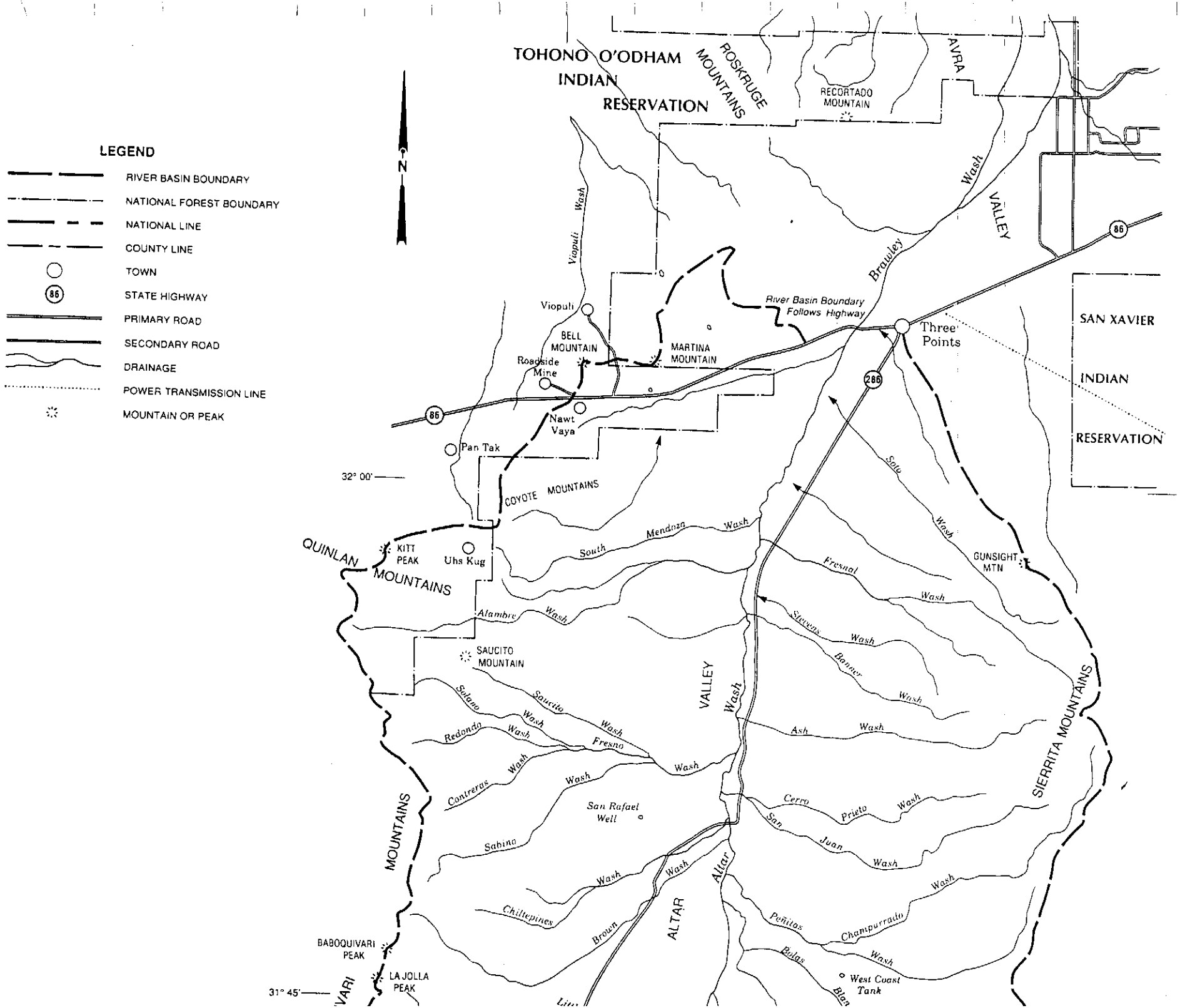
The soils in this group are formed in gravelly, flagstone-covered, loamy alluvium derived dominantly from gneiss, granite and schist and are shallow to moderately deep and somewhat excessively drained to well drained. Elevation is 5,400 to 7,740 feet. Average annual precipitation is 16 to 20 inches. Slopes range from 10 to 65 percent. This group makes up about 5 percent of the watershed and is used mainly for recreation and some rangeland.

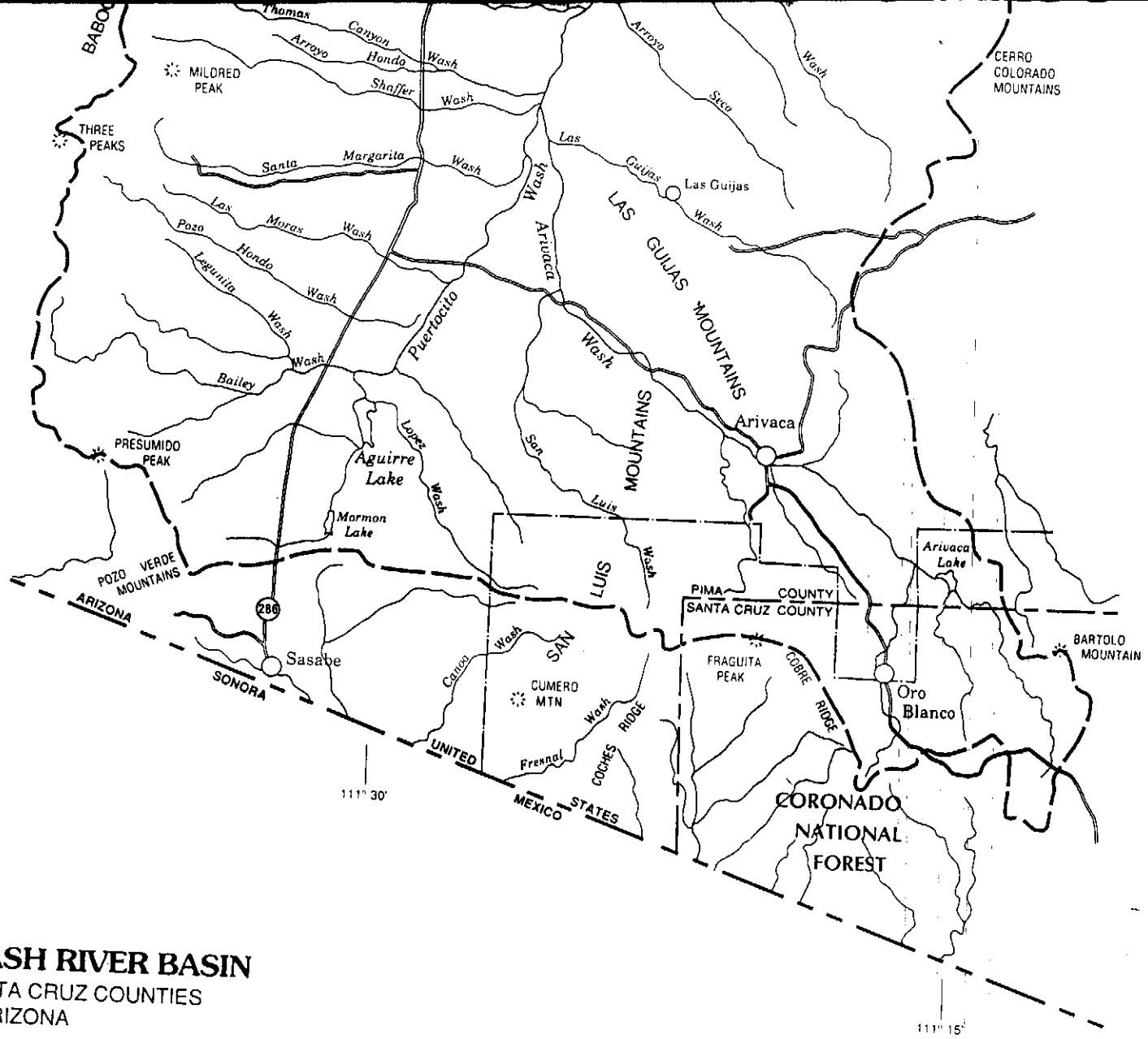
GEOLOGY

Brawley Wash flows from its origin near the United States-Mexico border in a northerly direction through the Altar and Avra Valleys to the Santa Cruz River near the Town of Marana. The valleys occupy a deep structural trough.

The watershed boundaries are formed by a series of partially detached mountain ranges. The west side of the valley is bordered by the Coyote, Baboquivari, Pozo Verde, Quinlan, Roskruge, Waterman and Silverbell Mountains. These mountains form a continuous chain typified by steep slopes. Baboquivari Peak rises to an elevation of 7,740 feet. The eastern side of the valley is bordered by the Tucson, Sierrita, Cerro Colorado, Guijas, San Luis, Oro Blanco and Tumacacori Mountains.

Granite of Pre-Cambrian age is the predominant rock type in the Serrita, Coyote, Quinlan, San Luis, Oro Blanco, and Pozo Verde Mountains. Granite also comprises the central portion of the Silverbell Mountains. Limestone of


LEGEND
RIVER BASIN BOUNDARY
NATIONAL FOREST BOUNDARY
NATIONAL LINE
COUNTY LINE
TOWN
STATE HIGHWAY
PRIMARY ROAD
SECONDARY ROAD
DRAINAGE
POWER TRANSMISSION LINE
MOUNTAIN OR PEAK
N
TOHONO O'ODHAM INDIAN RESERVATION
ROSKRUGE MOUNTAINS
RECORTADO MOUNTAIN
AVRA VALLEY
Wash
Brawley
Viopuli Wash
Viopuli
BELL MOUNTAIN
MARTINA MOUNTAIN
Roadside Mine
Nawt Vaya
Pan Tak
River Basin Boundary Follows Highway
Three Points
SAN XAVIER INDIAN RESERVATION
86
286
32° 00'
COYOTE MOUNTAINS
QUINLAN MOUNTAINS
KITT PEAK
Uhs Kug
South Mendoza Wash
Sasabe
Wash
GUNSIGHT MTN
Fresnal Wash
Stevens Wash
Banner Wash
Alambre Wash
SAUCITO MOUNTAIN
Solano Wash
Saucito Wash
Redondo Wash
Fresno Wash
Ash Wash
VALLEY Wash
SIERRITA MOUNTAINS
Contreras Wash
Wash
San Rafael Well
Cerro Prieto Wash
San Juan Wash
Sabino Wash
Altar
ALTAR
Chiltepines
Brown
Peñitas
Champurrado Wash
Bolas Wash
West Coast Tank
BABOQUIVARI PEAK
LA JOLLA PEAK
31° 45'
MOUNTAINS

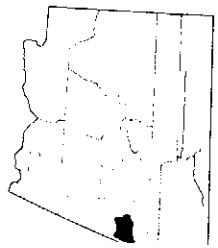


BRAWLEY WASH RIVER BASIN

PIMA AND SANTA CRUZ COUNTIES
ARIZONA

0 5 10
MILES

0 5 10 15
KILOMETERS



Paleozoic age is exposed in small areas of the Waterman Mountains, the southern part of the Silver Bell Mountains, and in the Tucson Mountains. Sandstone and shale of Cretaceous age is found on the flank of the Baboquivari Mountains, the slopes between the Guijas and San Luis Mountains, and on the west side of the Sierrita and Tucson Mountains. Intrusive granite and porphry of Cretaceous age is also found in the Sierrita and Tucson Mountains. The Cerro Colorado, Baboquivari, Roskruge, Waterman, and Silverbell Mountains are predominantly lavas of Tertiary age.

The lower mountain slopes transition into a pediment surface of moderate slope. This surface is covered by a thin mantle of gravel and rock debris. Bedrock is present at shallow depths on this surface.

The lower slopes of the pediment surface grade into the lowland area of the valley floor. The valley floor is underlain by several thousand feet of alluvium ranging in age from Tertiary to Recent. The alluvial Valley fill deposits underlying the Valley floor are important sources of ground water. Studies are being conducted by the City of Tucson to evaluate the potential of artificial ground water recharge to the underlying strata. The Recent alluvium consists mainly of sand and gravel with some silt and clay. The Fort Lowell formation of Quaternary age underlies the Recent alluvium. It consists of a sequence of unconsolidated to weakly lithified, interbedded, clayey silt, sandy silt, sand and gravel (Davidson, 1973). The Tinaja beds are generally divided into three zones; lower, middle, and upper. The upper Tinaja beds consist of a sequence of heterogeneous deposits of unconsolidated to weakly lithified, interbedded, clayey silts, sandy silts, sands and gravels (Davidson, 1973). The middle Tinaja beds are mainly moderately lithified, gypsiferous, anhydritic, clayey silt and mudstone. The lower Tinaja beds consist of clayey silt, mudstone, gravel, and moderately lithified conglomerate.

LAND USE/OWNERSHIP

The Brawley Wash study area covers 506,880 acres. Land ownership is as follows:

Land Ownership	Acres	%
State of Arizona	268,646	53%
Private	86,170	17%
US Fish & Wildlife	81,101	16%
BLM & USFS	45,619	9%
Tohono O'odham Res.	25,344	5%

Of this land area 76% is rangeland grazed by domestic livestock on 25 ranch units. These ranches range in size from 640 acres to over 50,000 acres. Grazing is the predominant land use in the watershed. The grazed area supports about 5,100 mother cows producing about 3,800 calves or yearlings each year. This amounts to a gross value of nearly 2 million dollars in new wealth produced each year from renewable forage resources of the watershed.

Other significant uses of the watershed's renewable resources are hunting and fuelwood harvest. Due to the predominance of state land and heavy stands of upland mesquite in the Altar Valley, the Arizona State Land Department administers a fuelwood sales program. At present the state is selling an average of 100 cords of mesquite wood per year, although their management plan for this same area indicates a safe harvest of about 300 to 400 cords per year.

Hunting is a major recreational use of this watershed's wildlife resources. Deer, javalina, Gambel and scaled quail, mourning and whitewing dove, cottontail, Allen's and blacktail jackrabbits, mountain lion, and coyotes are numerous in this valley and are legally pursued by licensed hunters in their respective seasons. At one of the valley's ranches a public access system monitors actual use by recrea-

tionists. The system record illustrates the tremendous public use of this area for hunting. In 1986, 1,365 hunters spent 1,863 days on this 54,000 acre ranch, about 10% of the watershed, in pursuit of wildlife. This figure has grown steadily since then.

Nonconsumptive uses of this rangeland area include picnicking, birdwatching, rockhounding, photography, and sight-seeing. These are important uses which are becoming more and more pronounced. On the ranch mentioned above, the 1986 sign-in/out system indicated that 171 people spent 184 days in nonconsumptive pursuits. On the 87,000 acre Buenos Aires Wildlife Refuge nonconsumptive is the predominant use.

PROBLEMS AND OPPORTUNITIES

SUMMARY

The primary problems which have been identified are:

1 - Stream bank erosion and associated loss of riparian and range habitat along the Brawley Wash.

2 - Sheet, rill, and gully erosion and associated damages to rangeland and improvements.

3 - Sedimentation effects on downstream water quality, farmland, and county and state road crossings.

4 - Flash flooding and associated damages to roads, farmland and local communities.

5 - Loss of ground water recharge due to accelerated, concentrated flows within the incised wash.

Other problems/opportunities and related planning objectives that were identified and considered in the planning process are listed in Table 1.

INTRODUCTION AND HISTORY

The early settlers of the Altar Valley came in the 1860's and 70's from Mexico and California. Families of Spanish descent came first followed shortly after by anglos. These people established ranches in the valley and the flanking mountains where water could be obtained from shallow wells or springs (Robinett, 1981 and Wilbur-Cruce, 1989). Basically ranches existed by owning and controlling water places. According to the customs of the times, the owner of a water place controlled the range halfway to the next water.

When George Roskruge first surveyed the valley in 1886, he found no evidence of gullies in the valley floor (Cooke, Reeves, 1976). The axial stream was a floodplain varying from 1/4 to 1/2 mile wide and well covered with tall grass. By 1900, Johnson grass was well established in the valley and the ranches all put up hay cut from the flooded bottom lands.

By the turn of the century the large herds of cattle, horses, and burros became a new impact on the dry grassland of the valley. Grazing pressure was unnaturally high compared to that exerted by native herbivores such as antelope, jackrabbits, and grasshoppers. These herds were stripping the watershed bare of its protective cover of grass. Early photographs in this part of Arizona show the severe overgrazing of this era (Hasting and Turner, 1965, Humphrey, 1987, and Myrick, 1981).

Up until about 1916, the valley was open range. At this time ranch boundary fencing started, with state land secured from the public domain upon passage of the Enabling Act. State land was assigned by the commissioner to the owner of existing water places, both as the area's natural tributary to those waters and in size commensurate with the amount of patented land the rancher held. Ranch boundary fencing was largely completed by 1920.

In 1920, livestock numbers were high and the animals were restricted by the new fencing. The summer was

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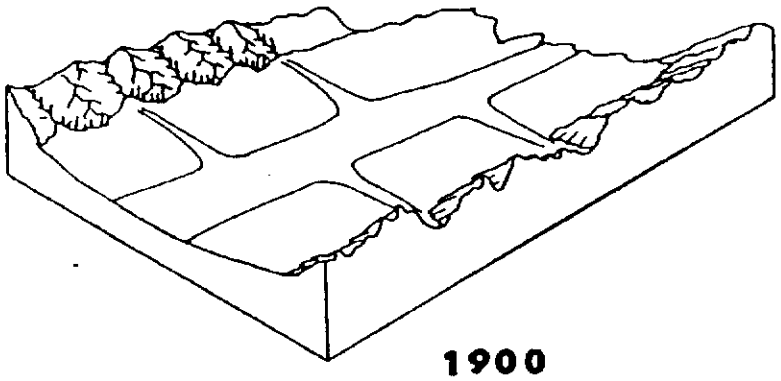
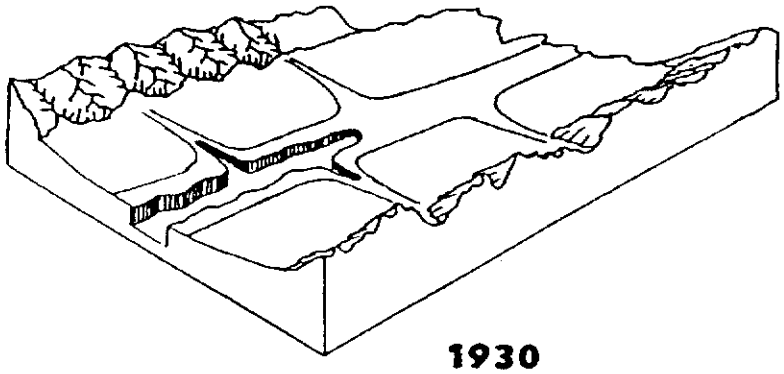
Table 1
BRAWLEY WASH
NATURAL RESOURCE PLAN

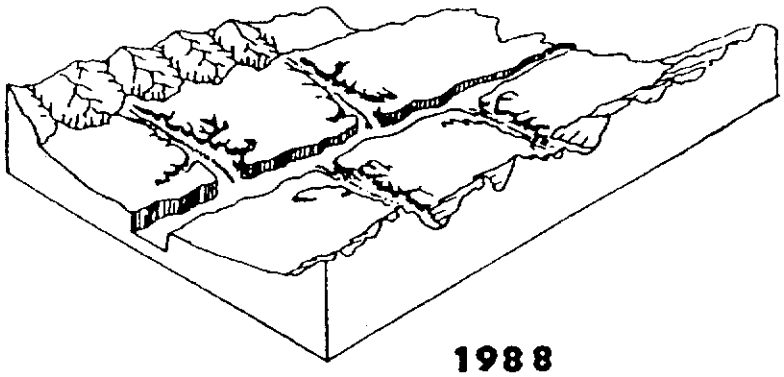
PROBLEM/OPPORTUNITY	PLANNING OBJECTIVE
1. Soil Erosion	• Reduce soil erosion
2. Sedimentation	•Reduce sediment transported downstream of Three Points and contain sediment upstream of Three Points to reestablish the flood plain.
3. Flooding	•Reduce floodwater damage
4. Loss of range, riparian and wildlife habitat	•Improve and expand range and wildlife habitat
5. Water quality	•Improve surface water quality and maintain ground water quality
6. Loss of ground water	•Increase ground water recharge by slowing flood flows
7. Loss of desert vegetation by human destruction	•Increase and maintain desert vegetation
8. Water rights	•Define surface and ground water rights
9. Landfills	•Identify landfills and determine their hazard potential
10. Wetlands	•Identify and increase wetlands
11. Aesthetics	•Improve the visual quality of the gullied wash
12. Cultural resources	•Identify cultural resources
13. Endangered species	•Identify endangered species
14. Protected biological species	•Identify protected biological species
15. Air quality	•Improve air quality by increasing vegetation
16. Trails	•Identify existing trails



1900



1930



1988

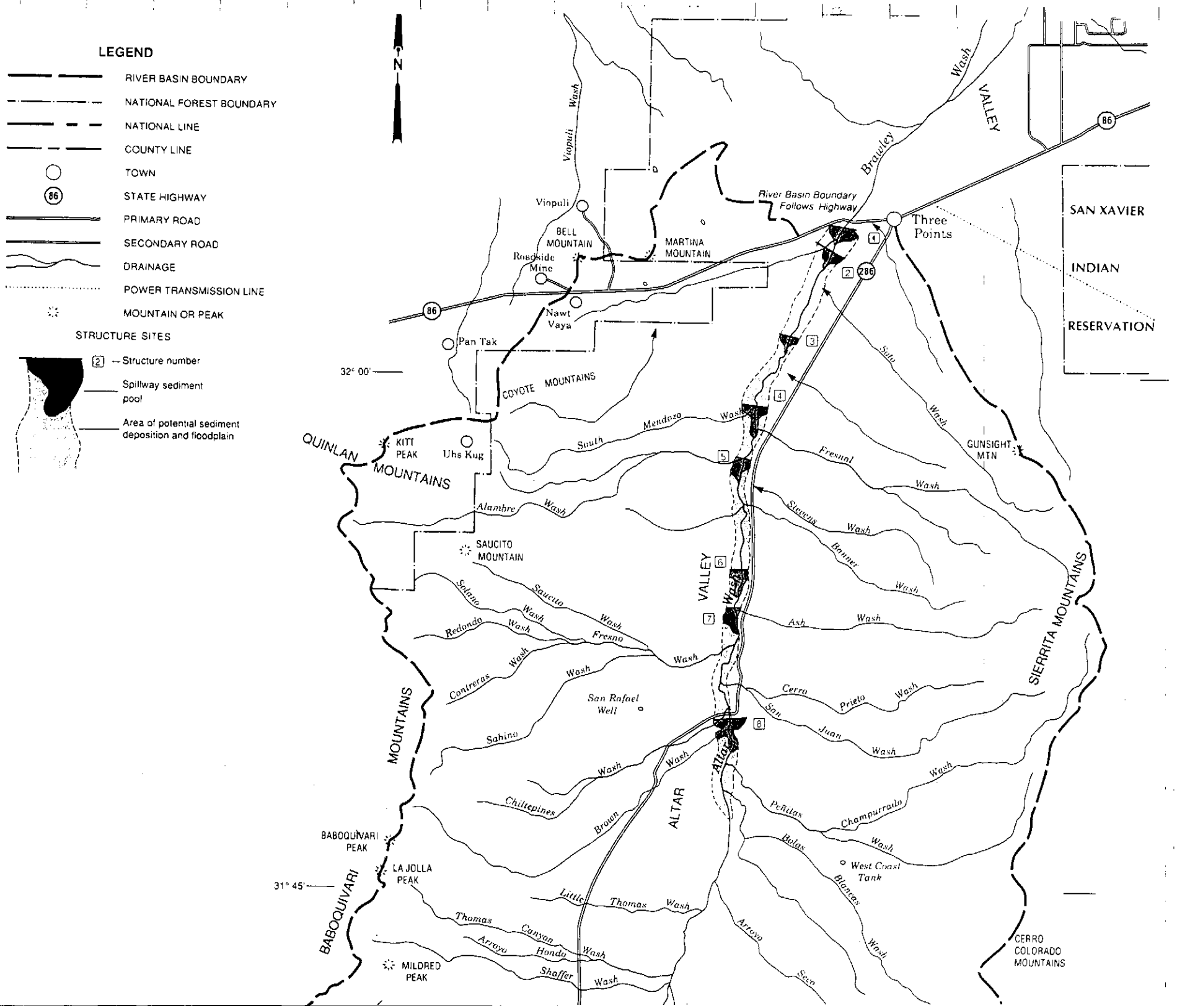
extremely dry and there was no market for livestock. Range areas formerly not used heavily were so used for the first time. The severe overgrazing and drought caused a great increase in runoff to the unprotected floodplain. Erosion began along man-made features including roads, fencelines, and field boundaries. By 1930 erosion had progressed to the point that the gully, or Brawley Wash, had traversed half of the valley. By 1937, it was up to 20-feet deep and in places 600-feet wide (Cooke, Reeve, 1976). Presently the depth is still 20 feet but in places it is over 1400-feet wide.

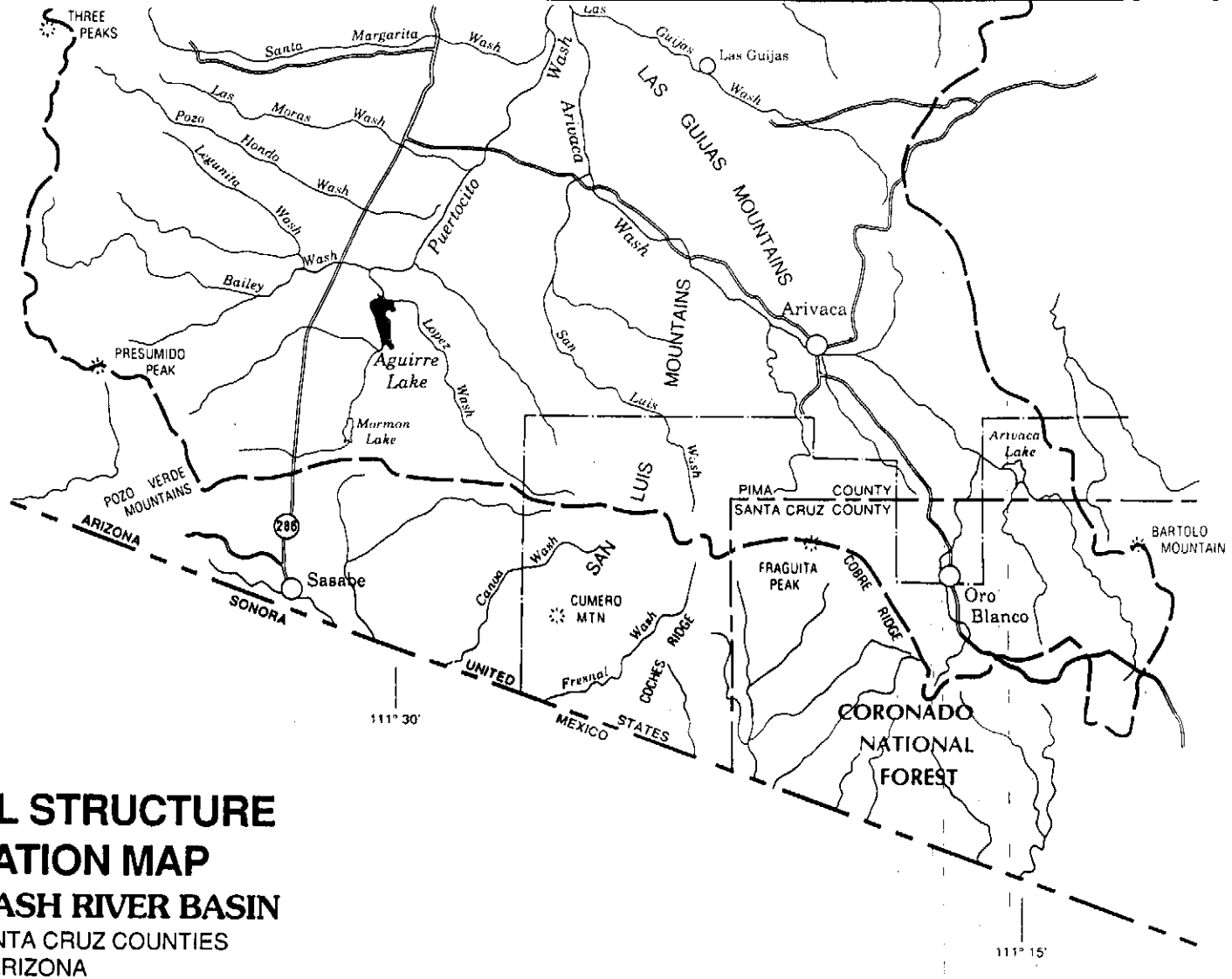
EROSION

The term erosion is defined as the detachment of soil and rock particles by water, wind, ice or gravity.

Erosion is occurring throughout the drainage area of Brawley Wash. The degree of erosion varies greatly from place to place in the basin, ranging from slight to severe. The erosion rates are greatly influenced by man's activities and the climatic factors.

The major types of erosion recognized in the watershed are: (1) sheet and rill, and (2) stream channel and gully. Sheet and rill erosion account for a majority of the total erosion in the watershed.


LEGEND
RIVER BASIN BOUNDARY
NATIONAL FOREST BOUNDARY
NATIONAL LINE
COUNTY LINE
TOWN
STATE HIGHWAY
PRIMARY ROAD
SECONDARY ROAD
DRAINAGE
POWER TRANSMISSION LINE
MOUNTAIN OR PEAK
STRUCTURE SITES
2 — Structure number
Spillway sediment pool
Area of potential sediment deposition and floodplain
N
Viopuli Wash
Viopuli
BELL MOUNTAIN
Roadside Mine
MARTINA MOUNTAIN
River Basin Boundary Follows Highway
Brawley
VALLEY
Wash
Three Points
SAN XAVIER
INDIAN
RESERVATION
86
286
Nawt Vaya
Pan Tak
32° 00'
COYOTE MOUNTAINS
QUINLAN MOUNTAINS
KITT PEAK
Uhs Kug
South Mendoza Wash
Soto Wash
GUNSIGHT MTN
Fresnal Wash
Alambre Wash
Stevens Wash
Banner Wash
SAUCITO MOUNTAIN
Solano Wash
Saucito Wash
Redondo Wash
Fresno Wash
Ash Wash
Contreras Wash
Wash
San Rafael Well
Cerro Prieto Wash
San Juan Wash
Sahino Wash
Chiltepines Wash
Brown Wash
ALTAR VALLEY
Altar Wash
Peñitas Wash
Champurrado Wash
Bolas Wash
West Coast Tank
Blancos Wash
Arroyo Seco
SIERRITA MOUNTAINS
CERRO COLORADO MOUNTAINS
BABOQUIVARI MOUNTAINS
BABOQUIVARI PEAK
LA JOLLA PEAK
31° 45'
Little Thomas Wash
Thomas Canyon Wash
Arroyo Hondo Wash
Shaffer Wash
MILDRED PEAK

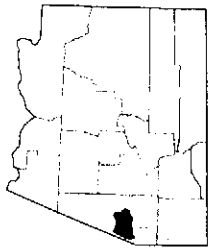


POTENTIAL STRUCTURE LOCATION MAP

BRAWLEY WASH RIVER BASIN

PIMA AND SANTA CRUZ COUNTIES
ARIZONA
DECEMBER 1990

0 5 10
MILES
0 5 10 15
KILOMETERS



VICINITY MAP

SOURCE:
BASE MAP COMPILED FROM 1:250,000 USGS QUADRANGLES,
COUNTY HIGHWAY MAPS AND INFORMATION FROM SCS FIELD PERSONNEL.
TRANSVERSE MERCATOR PROJECTION.

MAY 1991 1006622-01

USDA-SCS NATIONAL CARTOGRAPHIC CENTER, FT. WORTH, TX - 1991

Stream channel erosion due to unstable banks.

October , 1983 (middle) before erosion. Result of bank erosion (bottom left). Photos were taken at the Anvil Ranch Crossing.

However, stream channel and gully erosion are much more severe in localized areas. The effects of stream channel and gully erosion are highly visible. Stream channel erosion is most pronounced in the channel reach between Highway 86 and Highway 286.

The history of channel erosion is well chronicled by aerial photos made in 1936 and 1987. Erosion prior to that period is less precisely known. However, historical reports as mentioned in the Introduction and History section above, provide insight into the development of channel and gully erosion. At present the drainage system consists of a wide, well entrenched channel which continues to widen at a rapid rate. Many deep tributary gullies have further incised the valley floors and slopes.

The rate of land loss due to streambank erosion during the time interval from 1936 and 1987 was evaluated from aerial photographs for the channel reach between Highway 86 and 286. During that interval significant channel widening occurred due to bank erosion. The channel length also increased significantly due to channel meander. The average channel width in this reach increased from about 217 feet in 1936 to about 410 feet in 1987. The channel length in this reach was about 18.2 miles in 1936. In 1987 the channel length was about 19.5 miles.

During the time interval from 1936 to 1987 about 341 acres of land were lost to channel erosion between Highways 86 and 286. This erosion produced about 5,100 acre-feet of sediment. Currently, it estimated that the average annual rate of land loss for this reach is about seven acres. This generates about 100 acre-feet of sediment per year.

Under present conditions it is estimated that sheet, rill, and gully erosion is occurring at an average annual rate of about one acre-foot per square mile per year for the watershed as a whole. This equates to about 2.8 tons per acre per year. About 800 acre-feet of sediment are generated per year by sheet, rill, and gully erosion from the watershed. It is estimated that about 432 acre-feet of this sediment reach the Brawley Wash annually.

SEDIMENT

Sediment is the product of erosion and is defined as solid material that has been detached and is being transported or has been deposited.

Approximately 900 acre-feet of sediment are generated by all types of erosion in the watershed on an average annual basis. Under current conditions about 532 acre-feet of this sediment are transported past Highway 86 annually. Much of this sediment is deposited on rangeland and farmland when Brawley Wash overflows its channel. Some is deposited in the channel. The remainder of the sediment is transported to the Santa Cruz River which in turn conveys most of the sediment onto irrigated croplands and rangeland. Only a small portion of the sediment is transported to the Gila River, the outlet for the Santa Cruz River.

FLOODING

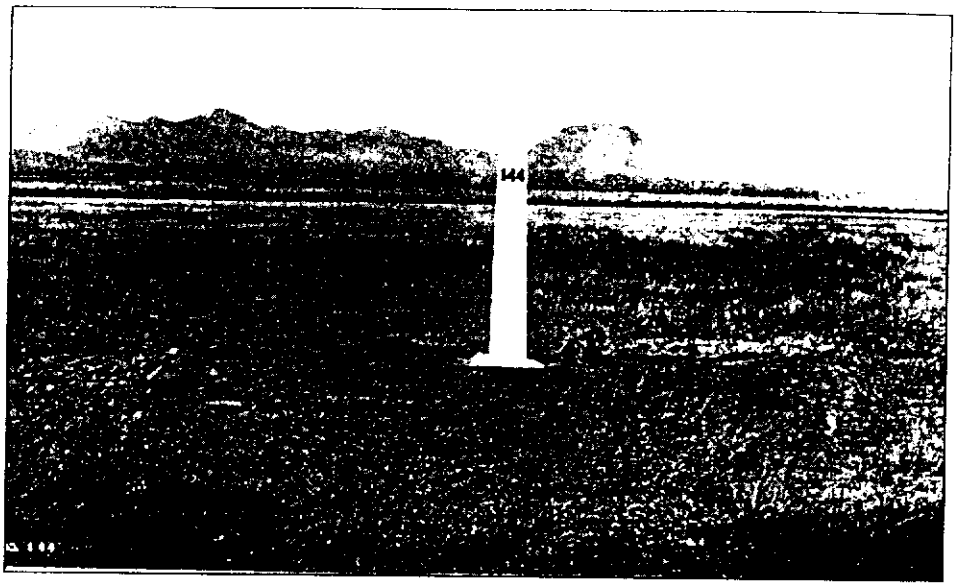
Prior to 1900 rancher John King's grandfather said he could walk a horse ahead of any flood in the valley. As mentioned in the Introduction, the valley floodplain at that time was covered with grass and there was no evidence of gullies.

The Brawley Wash has since been subject to erosion and gullying to the extent that it has become an efficient channel which concentrates runoff and transports floodwaters at a much higher flow rate. As a result, Brawley Wash sends floodwaters downstream to Avra Valley and Town of Marana.

Avra Valley consists of small braided channels bordered by narrow banks of dense vegetation, which cause the flood waters to spread over a wide area at shallow depths. The Garcia strip, within the Shauk Toak District of the Tohono O'odham Nation, is located in

Avra Valley and extends through the Brawley Wash drainage. Under the Southern Arizona Water Rights Settlement Act this area will become developed as agricultural land with irrigation improvements and some flood protection.

The Town of Marana is located in the area where Brawley Wash outlets into the Santa Cruz River. Urbanization in the Town of Marana and vicinity is increasing and development on the floodplain areas encroach on the main water courses.



In 1893 desert grassland occupied the area at Boundary Monument 144 (top). By 1983 shrubby species had spread and thickened.

HABITAT

The year 1920 probably saw the start of the large scale change of the valley's flora from grasslands to shrublands (Bryan, 1925). Burroweed and snakeweed were indigenous to at least the northern quarter of the valley prior to settlement. It was not until the early 1940's that they had moved as far south as the Elkhorn-Las Delicias Ranch area. The spread and thickening of these two species is very simply due to the continuous past grazing whereby forage species were slowly removed and these toxic species were able to occupy the vacant space left (Robinett, 1981).

Streambank erosion and the associated lowering of the water table and base floodplain has also removed riparian vegetation and limited further riparian habitat establishment and growth.

Throughout the 30's and 40's, shrubby species continued to spread and thicken. By the early 60's, rangeland carrying capacities had diminished to about the state-rated capacity. Photographs of the international boundary monuments taken in 1893 and again in 1983 show the result of this vegetative change (Humphrey, 1987).

GROUND WATER

Floods no longer spread over the wide Altar Valley floodplain but instead are concentrated within the incised wash and are quickly transported downstream. This flood action allows little stream flow recharge to the ground water aquifer in Altar Valley.

A reconnaissance study made after the floods of September 26-28, 1962, by the Ground Water Branch, U.S. Geological Survey, to determine the possibilities of recharge of the ground water reservoir supports this statement. Analysis of the available data from these studies indicates that some ground water was added to the ground water reservoir in the area from Stanfield to Maricopa, but no recharge or only a slight amount had taken place in the area to the southwest through Avra Valley to Three Points (USGS, 1963).

Therefore, an opportunity exists to regain some of the area's dwindling ground water with stream flow recharge. These ground water supplies are a major source of public drinking water for the Tucson metropolitan area, Marana, and Three Points.

INVENTORY AND FORECASTING

The majority of the Brawley Wash watershed lies within two Land Resource Areas. The Upper Sonoran Desert, MLRA 40-1 is the northern 1/3rd of the area, with average annual precipitation of 10 to 13 inches and elevations ranging from 2,400 feet to 3,200 feet. Most of the rest of the area is Desert Grassland, MLRA 41-3, with an average annual precipitation of 12 to 16 inches and elevations ranging from 3,200 to 4,500 feet. A small part of the area in the higher elevations is in the Mexican Oak Woodland-Savannah, MLRA 41-1, with an average annual precipitation from 16 to 24 inches and elevations ranging from 4,500 to over 6,000 feet.(USDA-SCS Az Tech Guides)

INVENTORY

Range

SCS assesses ecological range condition by comparing existing plant communities on a range site to the potential plant communities shown in the Technical Range Description. Condition is quantitatively rated as a departure from site potential.(USDA-SCS National Range Handbook, 1976)

About 229,000 acres of rangeland in this watershed are in poor or fair range condition using SCS methods (This does not include about 70,000 acres of land dominated by dense stands of Lehmann lovegrass which is an introduced species and cannot be rated in ecological conditions). Of this, 90,000 acres is on ranch units applying good grazing management with an upward trend leaving 139,000 acres in unsatisfactory condition without a positive trend.

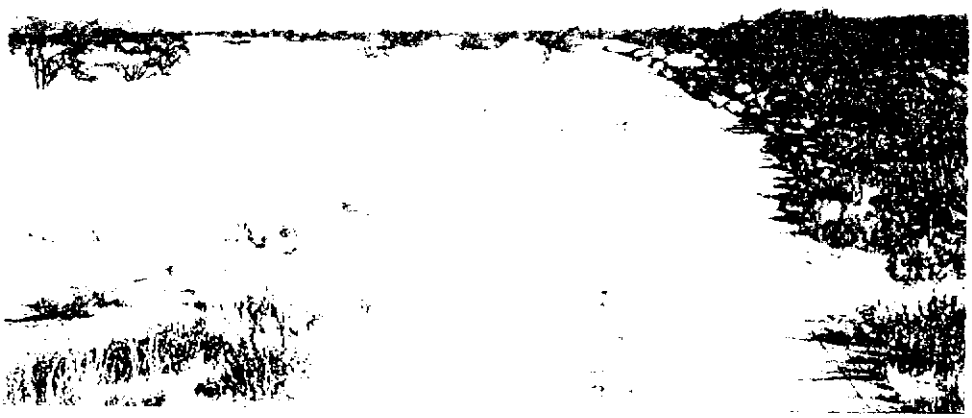
Of the 420,000 grazed acres in the watershed area, 251,000 (60%) have active management plans. Of these 251,000 acres 240,000 acres have grazing rotation schemes and 120,000 acres are deferred from summer grazing seasons. Through the grazing year, proper grazing use is achieved on about 140,000 acres.

Treatment needs in this area are predominantly related to thinning existing stands of "invading" mesquite to a point

where effective herbaceous covers can persist. The SCS in Southern Arizona has pioneered the use of prescribed fire in these deteriorated grasslands.

The first burns done in cooperation with the Buenos Aires Ranch and the Arizona State Land Department occured in 1978. Burns were done in May and June to remove burroweed and snakeweed and top kill mesquite, allowing perennial grasses a chance to reestablish. On one of the larger ranches in the northern part of the watershed, a prescribed burning program which began in 1985 has resulted in over 13,000 acres of actual burned land in four pastures totaling about 20,000 acres. The resulting treatment has left a mosaic of grasslands, shrublands, and tree-lined washes and has been a tremendous help to wildlife, recreation, watershed, and ranching values. It is estimated that 175,600 acres of the watershed still need some brush management to reduce the density of mesquite.

Prescribed burning on the West Mill Pasture, June, 1985. First summer after prescibed burn (Oct. 1985) (top). Site after second summer (Oct. 1986). (bottom).



Water

Brawley Wash is an intermittent wash which flows only after rainfall events on the watershed. There are no

perennial streams or creeks in the Altar Valley. Some headwater streams are perennial at least in some reaches. These include Arivaca Creek and San Luis Canyon.

Ponds in the area are man-made for watering livestock.

Springs are found only in the mountains adjacent to the broad valley.

Ground Water

Overall, ground water quality in the Avra Valley area is good to excellent (Block, Wieland, 1989). Water quality data in this area were evaluated in reference to EPA and State of Arizona public drinking water standards. Ground water results showed concentrations were below detection limits or at trace levels far below ADEQ action limits.

Wildlife

Several species of game animals are found in the area proposed for structural improvements. These species use the habitats immediately adjacent to Brawley Wash as well as other areas farther away. Although birds are mobile, this area probably provides critical nesting and forage during dry times of the year. Javalina, mourning dove, white-wing dove, mule deer, Gambel quail, scaled quail and cottontail rabbits are the game animals in the area.

These species will take full advantage of any increase in riparian plants or water resulting from structures along the wash.

Non-game species of wildlife such as many song birds, raccoon and ringtail are also found in the valley. (Lowe,1972)

Cultural Resources

Small fragments of pottery, stone flakes, and ground stone pieces appear to be scattered along the whole length of Brawley Wash. Only one potential structure location, however, met the requirements to be an archeological site as set out by SCS policy (SCS,1990). Staff archaeologists will be able to pin-point known sites early in the final site location process.

After sites are chosen for construction, a formal archeological and historical survey by a registered professional archeologist or the responsible land management agency will be completed, as will consultations per section 106 of the National Historic Preservation act of 1966.

Upon discovery of unknown buried resources during construction, the construction will be halted until appropriate consultations and mitigation plans are carried out.

Threatened and Endangered Species

After site selection is made, specific ground searches will be made along with consultations with the U.S. Fish and Wildlife Service as outlined in section 7 of the Endangered Species Act of 1973.

Masked bobwhite , Colinus virginianus ridgeway, is listed as endangered. The Altar Valley is historical range and with improvements might be occupied once again by this quail.

Tumamoc globeberry, Tumamoca macdougallii, is listed as endangered. It could possibly be found on upland sites impacted by proposed structures.(U.S.Fish and Wildlife Service, 1987)

Economic damages

Sheet, rill, and gully erosion reduce productivity of the soil and increase land management costs. Also, streambank erosion results in land loss, land depreciation, damage to wildlife habitat, and damage to improvements and facilities.

Up to this time, the land lost to channel erosion has been primarily rangeland with relatively low commercial value. Damages may increase in the future, however, as higher valued land closer to ranch buildings is threatened. Cattle fences are washed away

several times a year and ranchers must spend both time and money to replace them. In several cases cattle could be lost if streambanks near enclosed cattle pastures suddenly gave way. Other damages that have occurred due to bank erosion include the destruction of upland levees, water tanks and water wells. Also endangered is the potential site for the Tucson Ground Water Recharge Facility.

Headcuts have advanced up the sides of the foothills into the surrounding rangeland. These increasingly large incised tributaries are damaging state and local roads and threatening associated structures. Also, damages have occurred to these roads as a result of the deposition of sediment and debris and the deterioration from being submerged in flows.

State work crews have built and annually repair diversions and straightened channels to keep annual flows from causing major damages. However, bank erosion of the main channel is threatening State Highway 286 at the Palo Alto Ranch, and Rt. 86 at the bridge crossing.

During a recent storm event, the work near State Highway 86 was completely washed away and the old channel became re-established. This channel has begun to take a course that will outflank the bridge abutment. The structure is in no immediate danger but some remedial measures will be required in the future.

Sediment derived from accelerated erosion in the Brawley Wash contributes to many offsite damages. State and local highway authorities estimate annual sediment cleanup costs to area roads at approximately $45,000. This includes the time crews must repair damage due to advancing gullies.

It may take highway crews up to 8 hours to clear sediment from blocked roadways. However, no medical emergencies have been exacerbated by the time needed to remove sediment or for the flows in the washes to recede. Accidents have occurred in the past due to sediment and flooding, but they are not well documented.

FORECASTING

Ranchers using the SCS Conservation Operations Program (CO-O1) have made significant improvement to the land in the last 15 years, considering that in 1975 not one ranch unit in this area utilized any grazing rotation scheme. An average of one large ranch unit per year has developed a plan and started a grazing system in this valley. If this level of assistance and implementation is maintained over the next ten years virtually all of the grazed acres will be under conservation plan and good grazing management.

Unless remedial measures are undertaken to reduce bank erosion the channel banks of Brawley Wash will continue to erode and fail due to slumping. The channel will continue to widen, thereby causing additional land loss. At present, the average annual rate of land lost to streambank erosion is estimated to be about seven acres per year.

As the channel banks recede, many miles of dikes will be destroyed. This will in turn allow runoff from adjacent lands to flow in an uncontrolled manner over the channel banks. As a result, much of the valuable floodplain land will experience serious damage due to gullying. Vegetation will be deprived of the runoff water. Plant vigor will suffer, thereby depriving wildlife and livestock of valuable forage. Riparian vegetation on the channel banks will be lost as banks continue to fail.

Improvements such as farm buildings, wells, fence and highways will be in jeopardy if the channel continues to widen and meanders enlarge.

The amount of sediment transported downstream will increase if the dikes along the channel bank are lost and additional gully development is initiated. Productivity of the

gullied land will be lost. Additional sediment will cause aggradation of the channel downstream from Highway 86, causing more frequent overflow of the channel. This will cause more sediment deposition on range and farmlands.

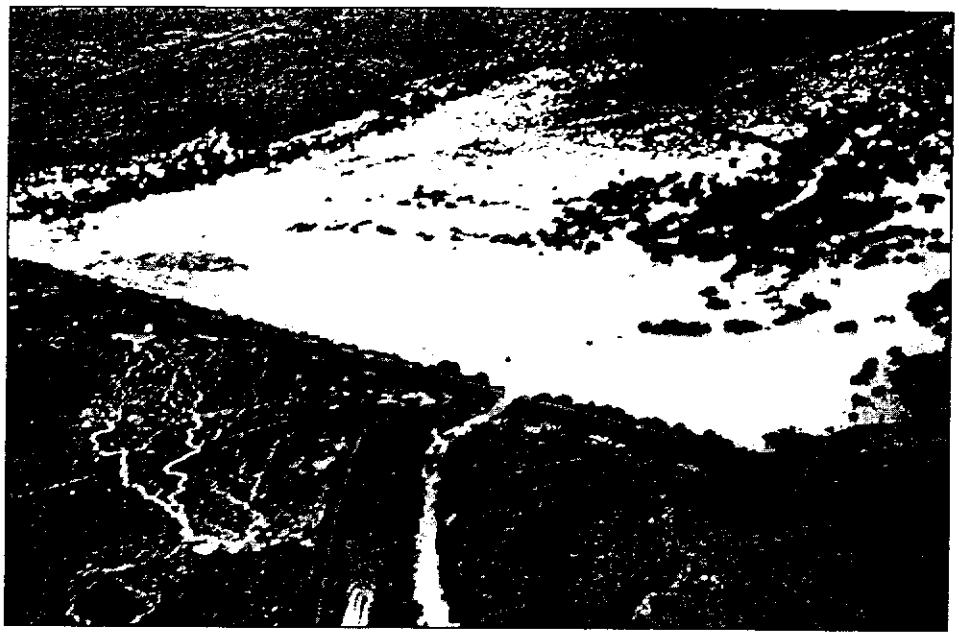
ALTERNATIVES AND IMPACTS

FORMULATION PROCESS

The main objective of this study is to develop alternatives that will control overall watershed erosion which is adversely impacting the area's natural resources, land values, and structural features.

Although conservation efforts over the past 15 years have proven to be very effective at controlling erosion and improving land conditions in the small upper drainage areas, the vast quantities of the type of structures involved are overwhelming. Similar treatment measures to control erosion in the Brawley Wash have proven futile.

The Pima NRCD has pointed out a solution that has been installed for similar problems on the San Simon watershed in southeastern Arizona. In 1953 the first of a series of grade control structures was constructed which was designed to catch sediment and restore the incised wash to its original floodplain. Today this structure has regraded the floodplain for a length of 10 miles and trapped approximately 19 million tons of sediment. This concept of erosion and sediment control also applies to the Brawley Watershed which is in an actively eroding state. Retaining the sediment produced along with vegetative management of the rehabilitated, sediment filled area will promote regrading of long reaches of the incised wash and its tributaries.



The Bureau of Land Management "Fan Structure" in the San Simon Valley during the 1983 flood

Therefore, the formulation of alternatives for this project was guided by the concept of reestablishing the base level of the area's historic floodplain.

Using this concept to guide the planning process the following options were considered in developing alternatives to solve the existing problems:

1. No action.
2. Grade control structures.
3. Option #2 plus vegetative management.
4. Combination vegetative/structural streambank and channel stabilization.

After preliminary analysis of stream flow conditions option #4 was not considered a viable alternative. Treatment measures including vegetative plantings along with structural measures such as spider jacks, Kellner jacks, flatbed railroad cars, gabion jetties, and sheet piling are best suited for sinuous stream conditions with

velocities less than 10 fps. Brawley Wash exceeds these parameters with many long, straight and narrow channel reaches having velocities that exceed 20 fps. Even the velocities in the main channel of the wide meander sections exceed 10 fps. Therefore, installation of these practices alone is not recommended.

ALTERNATIVES

Alternative #1, No Action

Refer to the Inventory and Forecasting section of this report for forecasted conditions without a project.

Alternative #2, Grade Control Structures

The purpose of these structures is to control erosion in the natural channel and prevent the advance of gullies or head cutting in the tributaries. This is accomplished by trapping and storing sediment upstream of the structure by using a combination of practices which include earth embankments and structural and earth spillways.

Spillway Types:

Earth or water spreading type spillways alone will not be stable without a structural spillway outlet immediately downstream to return flows to the Brawley Wash. In addition, the relatively steep side slopes of the valley will limit the location of the water spreading type spillway to the extreme northern part of the watershed.

A "mass" type spillway (non-reinforced) was investigated. Construction materials for a mass spillway could consist of roller compacted concrete or lean concrete. These materials lend themselves to stair-stepped spillway designs which typically simplify overall construction operations and project costs (see figure 1). Several types of structural spillways could also be used. The most common are the Bureau of Reclamation baffle chute, the Corps of Engineers SAF basin, and the SCS type C drop structure. Based on the energy dissipating capabilities of these structures and the site conditions of the Brawley Wash the baffle chute would be recommended over the others (see figure 2). A comparison of the baffle chute and stair-stepped structures is shown in Table 2.

Structure locations:

Potential structure locations (see potential structure location map) and structural features were discussed at a public meeting.

It was agreed either sites number 1 or 2 located near the highway 86 bridge would be best for spreading the water over the greatest amount of area and maximizing flow duration. The group also pointed out that it would be preferred to begin at the most downstream (northern) end of the watershed and work upstream in order to restore the maximum amount of potential area before locating the next structure site.

The City of Tucson owns most of the land in this area and their future land use is in question. Tucson Water, the municipal water utility, has constructed a pilot surface recharge facility next to Brawley Wash to assess the area's recharge potential. If the pilot project shows that a fully-operational recharge facility is feasible, a permanent facility may be built. However, constructing a permanent facility is dependent on whether the Bureau of Reclamation builds a Central Arizona Project terminal storage reservoir in the immediate area.

Site #5 is a favorite for a possible demonstration or pilot project because of least costs, accessibility, and the least institutional constraints (one landowner who strongly supports the project). Installing a structure at this location would not jeopardize the future of reestablishing the downstream floodplain, however, the process would be prolonged, and the ultimate spacing between structures may not be achieved.

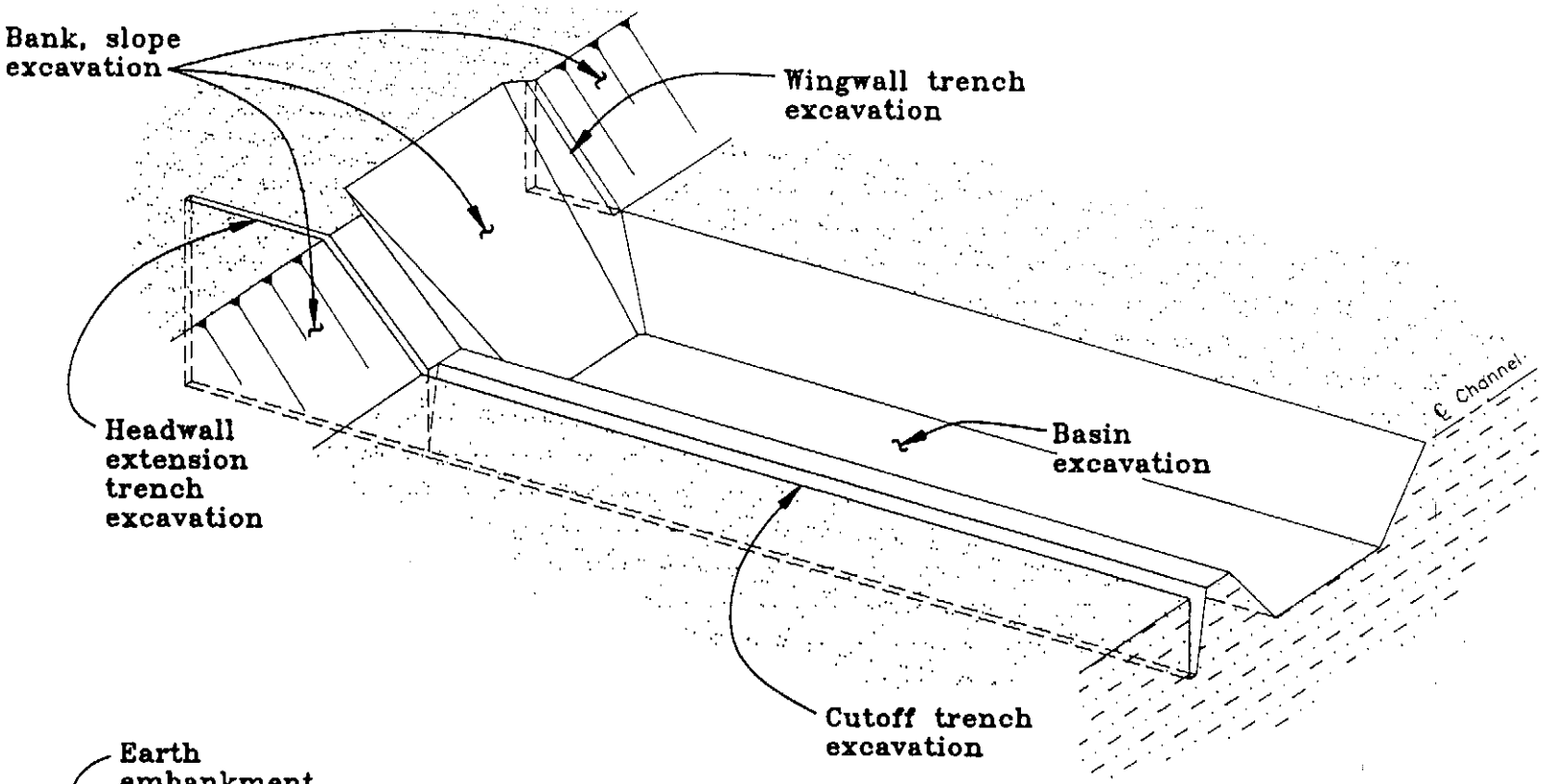
Table 2
COMPARISON OF GRADE CONTROL STRUCTURES

	STAIR STEPPED	BAFFLE CHUTE
Material/ Durability	Roller compacted concrete and/or lean concrete. Nonreinforced. Durability of the material depends on the mix design and aggregate material on hand. A very durable structure can be obtained.	Steel reinforced High strength concrete Extremely durable
Method of Construction	Stage construction: The spillway elevation can be increased over a period of time as sediment accumulates behind the structure (see figure 1). Roller compacted concrete is placed similar to earthfill operations. Lean concrete would be placed in lifts with minimal forming and less equipment and operators. Benefits: •will not store water, thus water rights should not be an issue, •course grain material will tend to fall out within the incised banks (high velocities will initially be maintained), thus promoting greater instream infiltration over the long term, •project costs can be spread over the period it takes to construct the spillway in stages. Limitations: •reduced quality control in construction, •lower initial trap efficiency, thus increasing overall restoration time.	Single construction: Constructed on top of an earth embankment to the designed spillway elevation using formed reinforced concrete (see figure 2). Benefits: •high quality control in construction, •high initial trap efficiency. Limitations: •initially stores water, thus having a potential water rights problem, •fine grain sediments deposited over the course grain wash material will limit instream infiltration.
Energy Dissipation	The stair–stepped spillway dissipates much of the energy gained through the fall of the previous step thus significantly reducing the size of the terminal energy basin needed.	Baffles within the chute break up flow and reduce energy to a stable condition.
Design Uncertainties	Confirmed by physical model testing but application is limited. Length of the terminal energy dissipating basin. *	A proven reliable structure for this application.
Project Costs for Structural Measures **	Construction*** $700,000 Eng. & Proj. Adm. $180,000 Total $880,000	Construction $1,000,000 Eng. & Proj. Adm. $250,000 Total $1,250,000

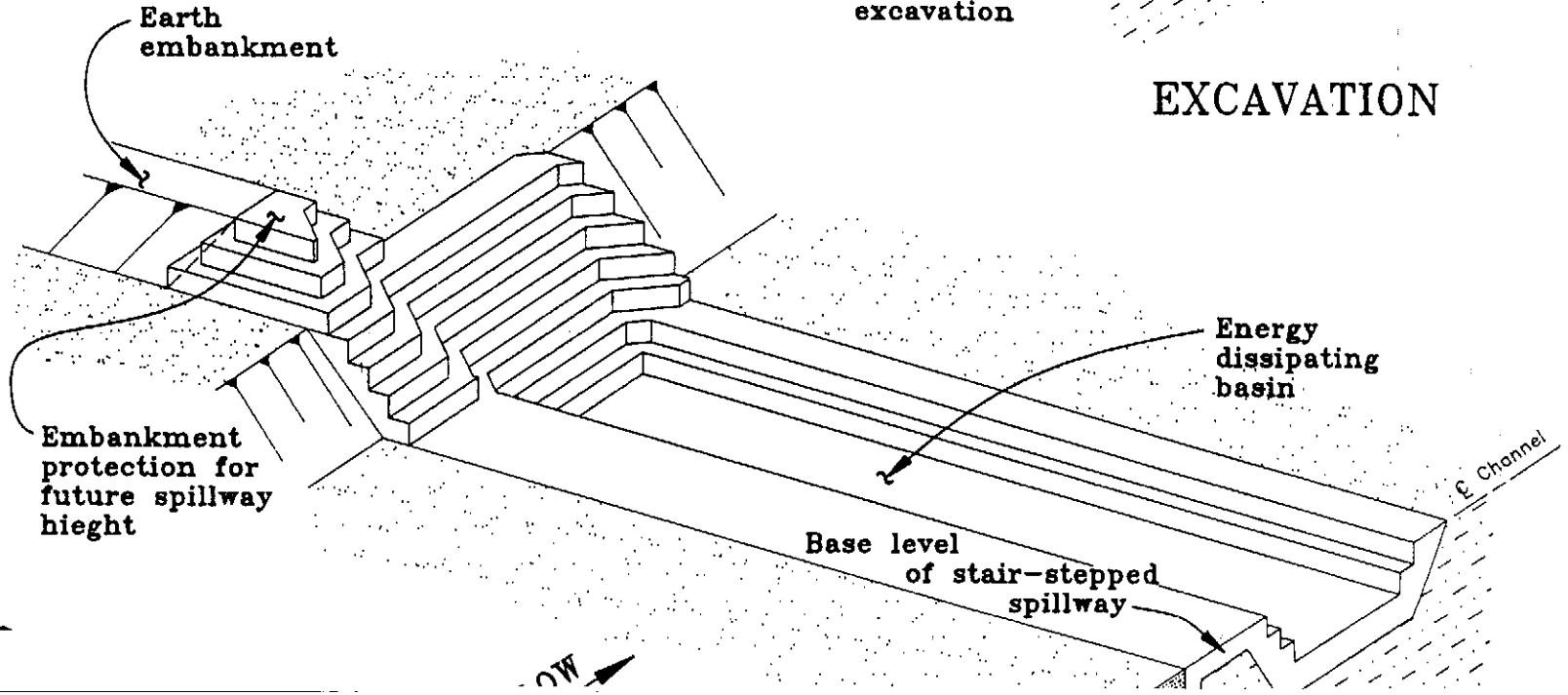
* Except for simple low flow conditions physical model studies are recommended to determine the crest shape, step geometry and terminal energy dissipating length.

** Includes spillway and all other structural costs for a typical site (assuming a 100 yr design discharge and a 300' wide and 20' high spillway), no landrights costs were estimated. 1991 price base.

*** For sites such as Brawley where significant terminal energy dissipating structures would normally be required, the costs of physical model studies are trivial when compared to the potential construction savings. Costs for a model study may range from $30,000 to $60,000.


Bank, slope excavation
Wingwall trench excavation
Headwall extension trench excavation
Basin excavation
℄ Channel
Cutoff trench excavation

EXCAVATION


Earth embankment
Energy dissipating basin
Embankment protection for future spillway hieght
℄ Channel
Base level of stair-stepped spillway

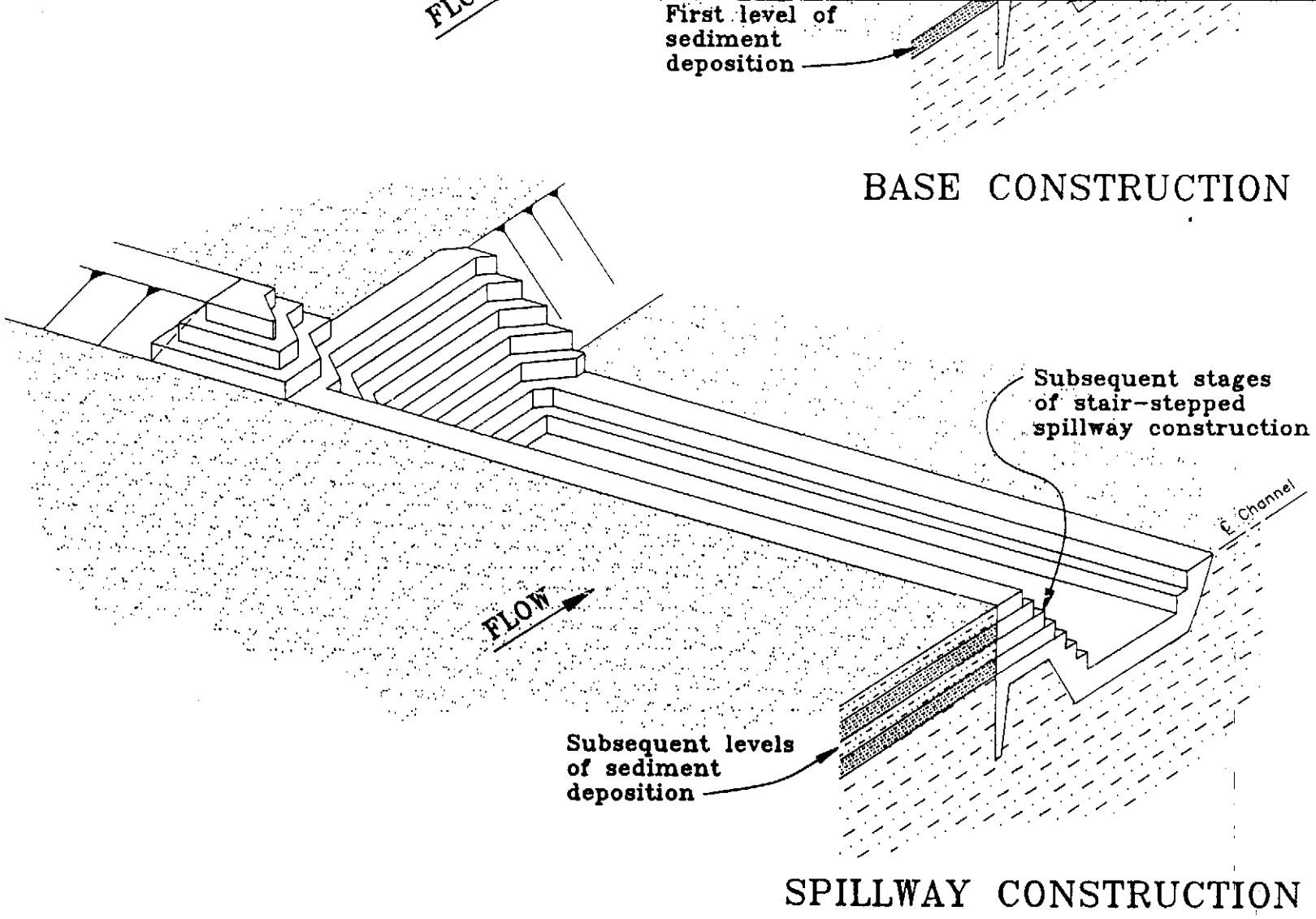
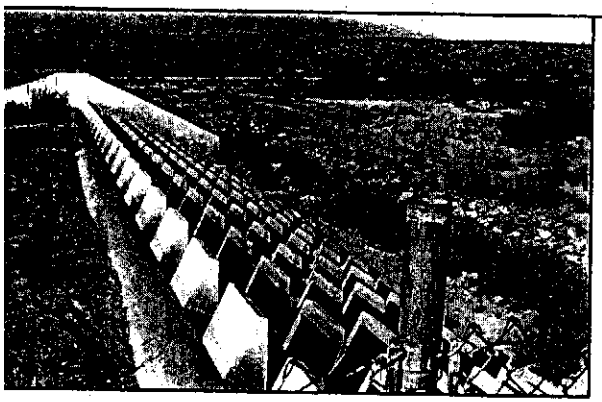


FIGURE 1

STAGES OF CONSTRUCTION
STAIR-STEPPED GRADE CONTROL STRUCTURE



baffle chute used for the "Barrier"
ructure in San Simon Valley.

FIGURE 2

BAFFLE CHUTE GRADE CONTROL STRUCTURE

Site selection criteria:

The following site selection criteria were used to select the potential structure locations:

1. Soil Erosion and Sedimentation

-Evaluate the type of erosion occurring upstream to determine the amount of sediment being transported to the site and the amount of time it would take to restore the floodplain. Bank, gully, sheet, and rill erosion contribute to the total problem. Evaluate each site to determine if additional erosion control measures are needed.

2. Flooding

-Analyze the reduction of peak runoff from the effects of infiltration and temporary storage behind a grade control structure.

-Structures should be located just downstream of wide meandering areas to obtain maximum temporary flood storage.

3. Loss of Range and Wildlife Habitat

-Provide maximum amount of restored surface area.

-Look for areas that would support vegetation better than others and types of vegetation that would help trap sediments to restore the floodplain.

4. Water Quality

-Select structure sites with maximum sediment storage potential, floodplain surface area, and vegetation potential in order to increase downstream surface water quality.

-Identify non-point sources of pollution in order to assess the potential for a decrease in ground water quality due to incidental recharge.

5. Ground Water Recharge

-The type of material that will deposit behind a structure will influence the amount of potential recharge. Consider the type of structure to be installed and the construction sequence.

6. Cultural Resources and Endangered Species

-Conduct a preliminary environmental investigation to determine constraints (an environmental evaluation and environmental assessment will be completed for specific sites after final selections have been made).

7. Topographic Conditions

-The treatment selected should best suit the topography. Get maximum results for the least structural cost.

8. Channel Alignment and Gradient

-Consider inflow and outflow spillway conditions in order to establish stable conditions.

9. Physical Properties of Soils

-Determine stability, foundation, and earthfill characteristics for construction suitability.

Impacts:

An average project site with a grade control structure will restore approximately 75 acres of incised land within the channel (37% of original grade or 7000' to 8000'in length) and create approximately 550 acres of floodplain. The time frame required to restore this area will depend on the type of structure installed and the number and intensity of storms. Anticipated benefits of restoring the incised wash to its original floodplain are: to create increased flowage area thus increasing flow duration, increasing the potential for ground water recharge, and reducing peak discharge. The resulting attenuation and infiltration could reduce 100 year peak discharges as much as 6000 cfs/structure and change the existing flow characteristics from a high velocity (20 fps) channel condition to a low velocity (2.5 to 5.5 fps) floodplain condition.

In addition the structure will reduce or eliminate bank erosion and reduce sediment yield from the watershed. This will result in decreased land loss due to channel erosion and a decrease in reoccuring damage to fences and structures along Brawley Wash.

Potential damage to state and county highways and the City of Tucson ground water recharge facility could also be eliminated.

The simple act of filling the Brawley Wash for portions of its length will also greatly improve the esthetic or scenic values of the area. Increases in the existing vegetation will improve habitat and the production of game species such as mule deer, javalina, dove, quail, and rabbits, thereby increasing hunting opportunities.

Construction activities will temporarily degrade local air quality due to dust and smoke and two to seven acres of desert vegetation will be removed per site selected.

Existing incised wash (top) and a computed generated image of the same area based on the installation of a grade control structure and vegetative management (bottom).

Alternative #3, Grade Control Structures Plus Vegetative Management

This alternative consists of the grade control structures described in Alternative #2 plus vegetative management in both the floodplain areas which develop above the structures and vegetative management along existing channels downstream of the structures. Such management will allow riparian vegetation to develop, provide additional soil erosion protection, restore longer reaches of the incised wash, provide forage for wildlife and livestock, and modify vegetation to allow for ground water recharge.

Sediments accumulating behind the structures need to be stabilized with herbaceous vegetation as soon as the level of the original floodplain is reached. Grass species such as sacaton, blue panic, Bermuda, and Johnson can be planted.

The natural tendency for a floodplain developing in the lower Altar Valley will be to go to mesquite. Seeds from upstream will be deposited with the sediments accumulating downstream with ideal conditions for germination and establishment. Seeding grass in areas before mesquite establishment will help prevent this occurrence, keeping the entire bottom from becoming mesquite thicket.

Grassy areas will also have to be maintained by using fire or mechanical means to keep mesquite from taking over. This will enhance ground water recharge as the shallow rooted grass plants (6-8 feet) will not dry deep soil horizons, but will allow gravitational water to move down towards the aquifer.

Riparian type trees will have to be introduced to the floodplain by pole planting using dormant stub techniques. Fremont cottonwood, black willow, coyote willow, netleaf hackberry, desert willow, and perhaps western soapberry and black walnut would be the adapted native species. Cottonwood and the willows could be dormant stub planted in mottes or groves in wet spots on the floodplain. The other species would have to be established from potted plants or seed.

Besides providing habitat for wildlife, riparian areas will improve both water and air quality. Water quality will be improved by: 1) processing chemical and organic pollutants, 2) reducing sediment loads and turbidity of flood waters, and 3) using nutrients for plant growth. Air quality, which affects the nearby Tucson population, will be improved by reducing the amount of blowing dust produced from the dry stream terraces.

The ideal resultant community for the largest array of resource value would be to have large grassy areas (2/3rds of total) dotted with groves of riparian trees along with an irregular edge of mesquite bosques and upland plant communities.

Dense growths of mesquite, athel, and catclaw acacia should be established to help stabilize existing banks below the structures. This process could be hastened by dormant stub plantings. Adapted species for this drier, harsher environment are limited to desert willow, athel, and arundo (bamboo). The channel downstream should be fenced and not grazed to allow maximum vegetative growth to occur.

The floodplain area will have to be fenced separately from adjacent uplands to establish and effectively manage the vegetation. Grazing should only be done in the fall, winter, or spring. Enough grass and litter must be left to protect the floodplain soil from erosion during the first floods of the following summer rainy season. Grazing should not be done in the summer when trampling damage could occur in boggy soils and where heat, humidity, and insects would reduce livestock performance.

Grazing in the dormant season will help keep grassy areas vigorous and create openings for seed eating birds to use in the winter, and for birds of prey to catch their fare.

Treatment of Brawley Wash to restore the floodplain will have a great impact on the forage produced on those ranches directly affected by the wash. One acreof floodplain will produce the same amount of grass 8 to 10 acres of upland range sites in this valley.

An average project site with a grade control structure and the addition of vegetative management has the potential of restoring and creating more than double the amount of voided land within the incised wash and floodplain area respectively.

Recreational land uses in the Altar Valley are mainly centered around the wildlife and visual resources of the area. These uses will be enhanced by vegative treatment of the floodplain and will provide the necessary environment for the establishment of areas of deciduous riparian woodland (cottonwood, willow) where none now exist except at Arivaca. This will greatly enhance both wildlife and scenic values.

Costs for vegetative management practices are shown in Table 3.

Table 3
***COSTS FOR VEGETATIVE MANAGEMENT PRACTICES AT A TYPICAL SITE**

WORK OR MATERIAL	QUANTITY	COST
Seedbed preparation and seed mixture	370 acres	$ 9,250
Fence	20,000 feet	$ 50,000
Dormant stub plantings	25 acres	$ 50,000
TOTAL		$109,250
Maintenance		$ 740/yr.

** 1991 Price Base*

PERMITS AND COMPLIANCE

Section 404 of the Clean Water Act requires a Corps of Engineers permit for the discharge of dredged or fill material in navigable waters of the United States.

This program provides for consideration of all concerns of the public--environmental, social, and economics--in the Corps decision making process to either issue or deny permits.

The project may not need to be considered for recharge permits by the Arizona Department of Water Resources (ADWR) and Department of Water Environmental Quality. Recharge projects are solely for the purpose of replenishing the ground water supplies to store water for the purpose of future withdrawals. The purpose of the structure being proposed in this study is to slow the water down versus capturing and storing it.

ADWR would need to review the project to determine the need for a surface water right permit. In comparing the types of grade control structures being proposed, ADWR reported that a structure built all in one phase (ie. a baffle chute), which would store water behind it until sediment reached the spillway elevation, would be more likely to need a permit than a structure built with staged spillway construction (ie. stair-stepped) where the spillway elevation is increased over a period of time as sediment accumulates behind the structure.

ADWR has a record of surface water right holders in the project area.

Under the authority of Pima County's Floodplain and Erosion Hazard Management Ordiance, 1988-FC-2, the Sponsors of this project would be required to obtain a floodplain use permit from the Pima County Flood Control District. Under this ordinance a review would be made to determine the impacts of the proposed project on existing and future development in the area.

IMPLEMENTATION OPPORTUNITIES

The 1990 Farm Bill known as the Food, Agriculture, Conservation and Trade Act (FACT) will provide conservation opportunities for wetlands, riparian areas, consevation reserve and conservation easements.

The Forest Stewardship Program is authorized under the FACT. Its main goal over the next five years is to get 25 million acres of trees planted and concurrently establish such practices as wetland protection and restoration, wildlife conservation, rare and endangered species protection, and soil and water conservation.

The Heritage Program was approved by Arizona voters November 6, 1990. The Arizona Game and Fish Department administers this program which allows for $10 million to be invested in habitat improvement practices and acquisition. This may be in the form of direct cost sharing with farmers and ranchers on practices that have positive impacts for habitat improvement.

The Bureau of Reclamation expressed interest in the project and has suggested potential funding opportunities through:

1) Soil and Water Conservation Authority,

2) funds for mitigation of lands in compensation for land taken by construction of the Central Arizona Project, and

3) as a means of flood protection for a potential ground water recharge facility along Brawley Wash.

ADEQ's Office of Water Quality, Nonpoint Source Unit is responsible for nonpoint source demonstration project proposals funded under Section 319 of the Federal Clean Water Act. Demonstration projects will include treatment practices to remedy agricultural and water quality problems. Through the demonstration process these practices could be expanded to other areas with similar conditions. Funds are assigned to priority projects as they become available.

Federal Aid to Wildlife Restoration Act of 1937 - Better known as the Pittman-Robertson Act, serves as the principal mechanism for providing assistance to states for acquisition, restoration, and maintenance of wildlife habitat for the management of wildlife areas and resources, and for the research into problems of wildlife management. The fund is comprised of revenues generated from federal excise taxes on the sale of firearms and ammunition. The United States Fish and Wildlife Service administers the federal program and the Arizona Game and Fish Department coordinates the State program. Over the last five years, Arizona has received over $10.7 million for projects relating to wildlife habitat development, enhancement, and maintenance. Other projects benefitting from the Act include the planning and evaluation of other agency projects as to their effectiveness for wildlife habitat improvement.

The Agricultural Conservation Program provides financial assistance to cost share in the installation of soil, water, and fish and wildlife conservation measures. For the past few years the major range conservation practices funded in this watershed have been:

-Fencing

-Livestock water developments (tanks, troughs, wells, pipeline...)

-Other (brush control, perscribed burning, seeding)

The Soil Conservation Service administers projects for the Department of Agriculture under Public Law 83-566, The Watershed Protection and Flood Prevention Act of 1954. These projects help urban and rural communities protect, improve and develop the water and land resources of the watersheds of up to 250,000 acres. PL-566 funds could be used for accelerated rangeland treatment measures on the smaller subwatersheds.

The Department of the Interior's Bureau of Land Management (BLM) is entrusted with stewardship of National

Trust Lands. BLM carries out a coordinated program for the conservation and development of watersheds in order to preserve and protect soil and water resources. The program is a combination of land and structural practices having a planned pattern in support of multiple use management. It is designed to regulate surface water runoff, to control accelerated erosion, and to stabilize the soil resources.

Range management practices, which are being installed under on-going USDA technical and cost share programs, should also be incorporated into this project plan.

CONCLUSIONS AND RECOMMENDATIONS

A "demonstration" grade control structure with vegetative management practices are recommended for Brawley Wash. The following evaluations should be completed for the demonstration project in order to provide site specific data that will aid in final project planning:

1) efficiency in trapping sediment,
2) length of floodplain effectively restored,
3) best vegetation and management practices,
4)floodplain flow characteristics,
5) surface and ground water quality impacts, and
6) ground water level changes.

Based on the data collected a series of future grade control structures can be planned.

APPENDIX A

Responses to Letters of Comment

Public/interagency review and comments were solicited. All comments were considered during the preparation of the FINAL report. SCS appreciates the efforts and interest of all who reviewed this document.

Following are excerpts from the letters of comment and SCS' response, if applicable:

TOHONO O'ODHAM NATION, CENTRAL ARIZONA WATER PROJECT
COMMENT:
"...Alternate #3..., it may be useful to lag or phase the vegetative management component until after examining the effects the grade control structure may have on the wash."

RESPONSE:
As stated in the plan the vegetative management component would be incorporated as soon as the level of the sediment behind the structure has reached the level of the spillway. Seeding grass will help prevent the entire floodplain from developing into a mesquite thicket and will promote continued sediment deposition upstream. The effects a structure will have on the wash and vegetative management strategy have been well documented by the San Simon project, in southeastern Arizona, which is similar. We do recommend in the report, however, that floodplain flow characteristics be monitored and evaluated for the specific site selected.

THE NATURE CONSERVANCY, ARIZONA CHAPTER
COMMENT:
"...your plan completely ignores one of the few effective and practical means of improving vegetation conditions, and thus erosion conditions, in the watershed over a broad area: prescribed fire."

RESPONSE:
Although prescribed fire was mentioned as a means of maintaining the re-established floodplain area we failed to mention that SCS pioneered the use of prescribed fire in this area in cooperation with the Buenos Aires Ranch and the Arizona State Land Department. We have provided this information within the Range Inventory section of the report.

COMMENT:
"In general, we are supportive of the goals and methods proposed in your plan to stabilize the continuing erosion in the Brawley Wash....Efforts to stop this erosion are commendable."

U.S. DEPARTMENT OF THE INTERIOR, BUREAU OF LAND MANAGEMENT
COMMENT:
"...we recommend removing the newly established floodplain from livestock production until the desired vegetation is established."

RESPONSE:
Alternate #3 of the plan explains livestock management. We have added to the narrative the fact that fencing will also be used to establish vegetation.

COMMENT:
"We agree the project is needed for the severely eroded Brawley Wash watershed..."

PIMA ASSOCIATION OF GOVERNMENTS
COMMENT:
"PAG staff recommends the report title be modified to reflect the project scope. We suggest...the addition of... Restoration after Natural Resources..."

RESPONSE:
We agree. The title of the plan will be BRAWLEY WASH NATURAL RESOURCE RESTORATION PLAN.

COMMENT:
"Include as part of the site selection criteria for water quality on page 41 that non-point sources will also be monitored....Ground water level monitoring should also be part of the scope for the pilot phase..."

RESPONSE:
We agree this information is needed, however, we believe that monitoring non-point sources such as domestic animals is part of the pilot or demonstration phase of evaluating the effect the structure and management plan have on surface and ground water quality and not a criterion for site selection.

We have added within the recommendation section of the report provisions to evaluate both ground water quality and ground water levels during the demonstration project.

PIMA COUNTY, DEPARTMENT OF TRANSPORTATION AND FLOOD CONTROL DISTRICT
COMMENT:
"Not clear within the plan is the disposition of land use activities that caused the erosion of the Brawley Wash....Post project benefits should be discussed and evaluated under assigned future land stewardship conditions."

RESPONSE:
No significant land use change is proposed. Grazing will continue to be the predominate land use in the watershed and post project benefits were discussed and evaluated using this assumption.

COMMENT:
"...some ranchers are employing the SCS CO-O1 program. Cooperation and program performance for the upstream ranchers would be useful....Financial underwriting of the structures should be contingent upon compliance with CO-01 and other factors."

RESPONSE:
As stated in the plan of the 420,000 grazed acres, 251,000 (60%) have active management plans. The number of planned acres continue to increase an average of one large ranch unit per year.
The SCS CO-01 is a voluntary program.

COMMENT:
"Perhaps the aforementioned issue and others could be clearly presented in an expanded economic section....A solid natural resource investment must withstand this sort of scrutiny."

RESPONSE:
The narrative section of each alternative and the summary section of the report explain the benefits. An expanded economic section would only emphasize that monetary benefits to costs for this project are slight and the environmental benefits are difficult to quantify for this level of study.

COMMENT:
"The recommendation for the structural alternatives should be expanded to list additional features that may be necessary to ensure success....If upstream stabilization and other features not listed to off-set the lack of soil integrity are necessary, the costs can increase significantly."

RESPONSE:
It is recognized that additional features will more than likely be needed. These specific features cannot be listed without final site selection, final geologic and soils investigations, and final design analysis. Estimated costs of these unforeseen items are incorporated into the cost estimate of this plan as contingencies.

COMMENT:
"An impact analysis of affected land use and accompanying structures within the new floodplain is necessary....Additionally, if flood limits change, it is necessary to know how are lands going to be impacted for purposes of grazing and development. If there are no impacts, state so clearly."

RESPONSE:
A preliminary floodplain flow analysis was completed and the approximate floodplain limits were determined. The structures were then planned so that there would be no impact or minimal impact to residents, commercial structures, and public infra-structures.

It is assumed that land use will not change in the foreseeable future and the grazing impacts will be as described in the narrative of the alternatives section.

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
COMMENT:
"The Department...supports the Soil Conservation Service and Pima Natural Resource Conservation District's proposed alternative #3 for implementation of grade control structures and vegetative management on the Brawley Wash....The Department also encourages the USDA Soil Conservation Service and Pima Natural Resource Conservation District to submit the finalized Brawley Wash Watershed Project for partial funding consideration as a 319(h) Demonstration Project."

TUCSON WATER, CITY OF TUCSON
COMMENT:
"We are of the opinion that the report provides good alternatives to deal with the continuing erosion problems along Brawley Wash. In particular Tucson Water favors the stair-stepped alternative with the phased construction as the selected solution."

ARIZONA STATE PARKS
COMMENT:
"...the overall project area can be regarded as extremely sensitive with regard to archaeological resources....Please note that the respective land managing agency will need to be contacted regarding cultural resource clearance for each specific site..."

RESPONSE:
A statement to this affect has been added to the cultural resources section of the report.

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