Erosion Control Program

Kahoolawe Island, Hawaii

Prepared for:

United States Navy
Pacific Division
Naval Facilities Engineering Command
Pearl Harbor, Hawaii

Prepared by:

United States Department of Agriculture
Soil Conservation Service

August, 1979

APPENDIX A

EROSION CONTROL PROGRAM

KAHOOLAWE ISLAND

PREFACE

The United States Department of Agriculture, Soil Conservation Service (SCS), at the request of the Department of the Navy, Pacific Division Naval Facilities Engineering Command, conducted a preliminary reconnaissance of the island of Kahoolawe in November, 1978. Recommendations were presented to the Navy after the review - that a conservation program be developed and implemented on the island, and that unique techniques not necessarily reflected in the SCS Technical Guide be utilized to fit the unusual conditions found on Kahoolawe.

On February 6, 1979, a cooperative agreement for the development of a conservation program for Kahoolawe was signed between the Navy and the Soil Conservation Service.

This plan is the result of that agreement.

CONTENTS

PLAN SUMMARY

This plan prescribes conservation treatment needed to reduce erosion and create more favorable conditions for re-establishing vegetation on approximately 10,000 acres of barren, eroding land on Kahoolawe.

Erosion problems in this area are complex. Overgrazing by feral goats and sheep, since their introduction in the late 1700's, has reduced vegetation to a point that combined wind and water erosion have eroded most of the area down to bare red parent material (saprolite). This, in combination with the constant wind and intermittent, intense rainfall and existing land use, has created an environment that restricts natural re-establishment of vegetation.

Earlier cooperative efforts between the U.S. Navy, the U.S. Soil Conservation Service, and the Hawaii State Division of Forestry supported by the U.S. Forest Service have resulted in the development of some techniques for successful establishment of vegetation on the island.

These techniques, along with control of grazing animals and other soil erosion control measures, will be utilized to create a more favorable environment allowing re-vegetating the barren portion of the island and reducing wind and water erosion.

DESCRIPTION OF THE ISLAND

Kahoolawe has an approximate area of 28,800 acres. It is wedge-shaped in outline, about 11 miles by six miles at the widest point. Its surface is undulating, dotted with a series of six small volcanic craters, the highest of which reaches an elevation of 1,477 feet on the eastern end of the island. Some of these accumulate water to form temporary natural reservoirs after heavy rains.

On the south and east the land rises from the sea in abrupt cliffs. On the north and west the slopes are more gentle, with gulches cutting deeply back from small bays. There are a few small sandy beaches, especially at the western end, but most of the shore is rocky.

Many archeological sites are present on the island. A number of these sites have been uncovered as a result of erosion over at least the last two centuries.

Almost two-thirds of the island, the portion located between sea level and approximately 700 feet elevation, is partially covered with kiawe and various shrubs and grasses. The remaining portion, approximately 10,000 acres, located between 700 feet and 1,477 feet elevation, is nearly barren and actively eroding. Some scattered clumps of vegetation exist in this area, but are barely existing and stand little chance of increasing or spreading under the harsh conditions they are subjected to.

The estimated average annual rainfall ranges from 25 inches at the higher elevations to 10 inches at the leeward, lower elevation areas. Much of the rainfall comes in the more intense winter-Kona storms.

EROSION PROBLEMS

The barren, eroded area on the island needs conservation treatment. Most of the soil material on approximately 10,000 acres has been removed by wind and water erosion, leaving a red hard surface over much of the area along with numerous gullies. Sediment deposits are found in the coastal waters on the north shores, and murky red waters can be found at various locations around the island after each runoff-producing rain. This condition is the result of almost 200 years of uncontrolled grazing by feral sheep, goats and cattle which freely roamed the island devouring most of the vegetation within their reach. The continuous exposure of the land to gusting trade winds, intermittent rainfall, along with lack of soil material and low fertility, has prevented any large-scale natural revegetation.

Severe erosion from runoff channeled down the access road from the eastern end of the island to Smugglers' Cove has caused hazardous conditions for vehicles. Without proper conservation measures and land treatment, Kahoolawe soils will continue to erode.

Rehabilitation of Kahoolawe will require a concentrated effort over an extended period of time. There is no short-term solution.

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ENVIRONMENTAL CONSIDERATIONS

The procedures recommended will create conditions on the island that will encourage spreading of adapted plant species already found on the island. The long-term revegetation goal of this plan will be achieved through the installation of the prescribed conservation measures, many of which are short-term or temporary in nature. The conservation measures selected will be compatible with the military training operations held on the island.

All locations for conservation measures shown or referred to are approximate. Specific locations will be determined onsite at the time they are installed.

The conservation measures recommended in this plan will have a long-term effect of reducing erosion around most of the archeological sites found on the island. These measures may have to be modified or installed on a different scale to protect specific sites from erosion.

PROGRAM IMPLEMENTATION REQUIREMENTS

The conservation measures in this plan are designed to reduce erosion and create a more favorable environment for re-establishment of vegetation. The following five points must be met for the prescribed conservation treatment to succeed:

1. The long-term success of this plan depends primarily upon successful revegetation of the island. This makes the elimination, or at least very stringent control, of feral goats paramount.

2. The 12-year tree planting project in the Lua Makika area will be implemented as described in the State Division of Forestry Conservation Project for Kahoolawe. In addition, other needed erosion control measures will be installed as shown in this plan.

3. Where gully control using check dams is utilized, the depth of the gully where the structure is built should not exceed 5 feet. No check dam will be more than 4 feet in height.

4. Vegetation will be planted only in the winter months (December through February) to take advantage of the winter rains. Installation of other recommended conservation measures may be carried out at any time.

5. The overall plan shall be jointly reviewed at least once every year by the cooperating agencies. Techniques or plant species may be added, modified, or substituted at any time.

PRIORITIES FOR CONSERVATION TREATMENT

The approximate locations where treatment will be applied are shown on the Conservation Treatment Location Map. Treatment should start at the eastern portion of the island in Treatment Area I. The State Division of Forestry tree planting and other needed erosion control measures will be installed in this area and in Area II. Conservation treatment should then proceed in sequence to Areas III and IV which are also located on the eastern portion of the island.

Conservation treatment for the road from Smugglers' Cove to Lua Makika (eastern portion of the island) will be installed when the next road maintenance operation is scheduled.

Next in priority will be the eroded area in Treatment Area V, the Kealialalo Crater area on the western end of the island.

The last area in priority will be Treatment Area VI, the target area.

Priorities may require adjustment in the future as needs and conditions warrant.

TREATMENT TECHNIQUES

1. Treatment Areas I, II, III, IV, and V

The various types of land treatments to be used are described below with illustrations and techniques for application (see Procedures 1-10) following.

A. Tree Windbreaks - All windbreaks will be a minimum of three rows of Tamarisk trees (Tamarisk aphylla). Windbreaks may or may not be supplemented with a row of buffelgrass (Cenchrus ciliaris) on the leeward side of the windbreak (see Procedures 1 and 10).

B. Soil Grabbers - Low wind barriers will be installed to trap sediment so that grass can be established and to serve as a temporary windbreak to protect Tamarisk trees and buffelgrass planted downwind of the barrier (see Procedures 2 and 3).

C. Sediment Retention Craters on Small Upland Drainage Areas - Craters will be blasted above small rills or gullies. Each crater will be planted with buffelgrass seed and/or 2 or 3 Tamarisk trees. The number and location of these craters will be determined onsite by SCS. This treatment will be used in tributary drainages no more than 10 acres in size and in special situations where trees and grass need to be established (see Procedure 4).

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D. Stabilizing Gully Heads - This will be accomplished by one or a combination of two primary types of structures.

(1) Covering or tying down the actual gully head with suitable materials such as rock or other appropriate materials as approved by SCS (see Procedure 5).

(2) Check Dams - These structures will be constructed in the area from just below the selected gully heads down to a point where the gully is no more than 5 feet in depth (see Procedures 6 and 7).

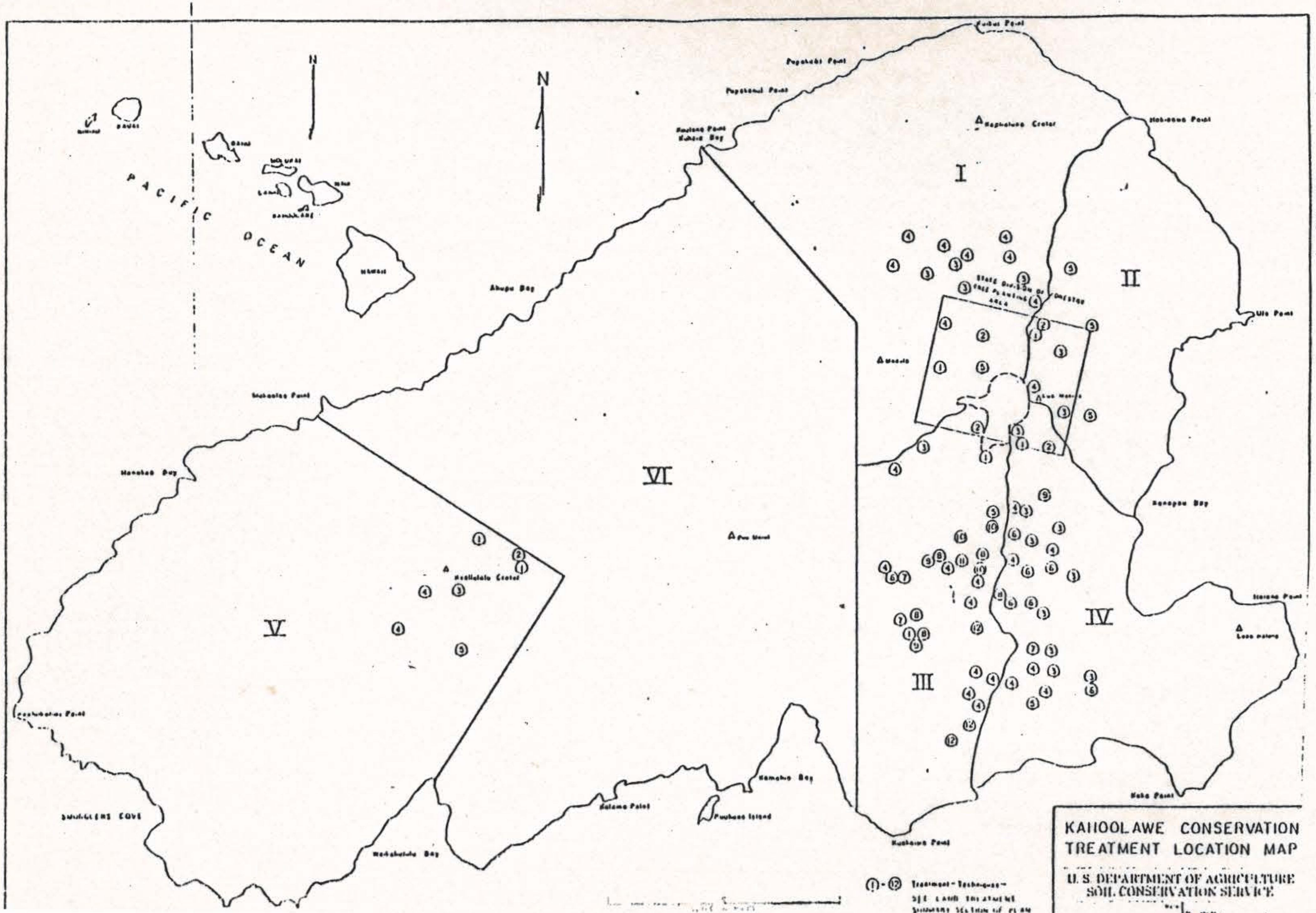
E. Spot-tree and Grass Plantings - Establish buffelgrass in combination with Tamarisk trees to stabilize small rills, gullies and gully heads in strategic locations to serve as a seed source so that wind-blown seed could settle and establish wherever growing conditions are favorable (see Procedure 8).

F. Drainage Berms and Outlets - The access road between Smugglers' Cove and Lua Makika should be realigned in some locations and drainage berms or water bars installed at various intervals and locations determined onsite by SCS (see Procedure 9).

2. Treatment Area VI

Vegetative treatment will be used primarily on this portion of the island since it receives regular scheduled bombing and shelling. Existing bomb craters will be planted to buffelgrass and Tamarisk trees (see Procedure 4).

If rock is readily available, gully heads may be covered for protection from erosion (see Procedure 5).



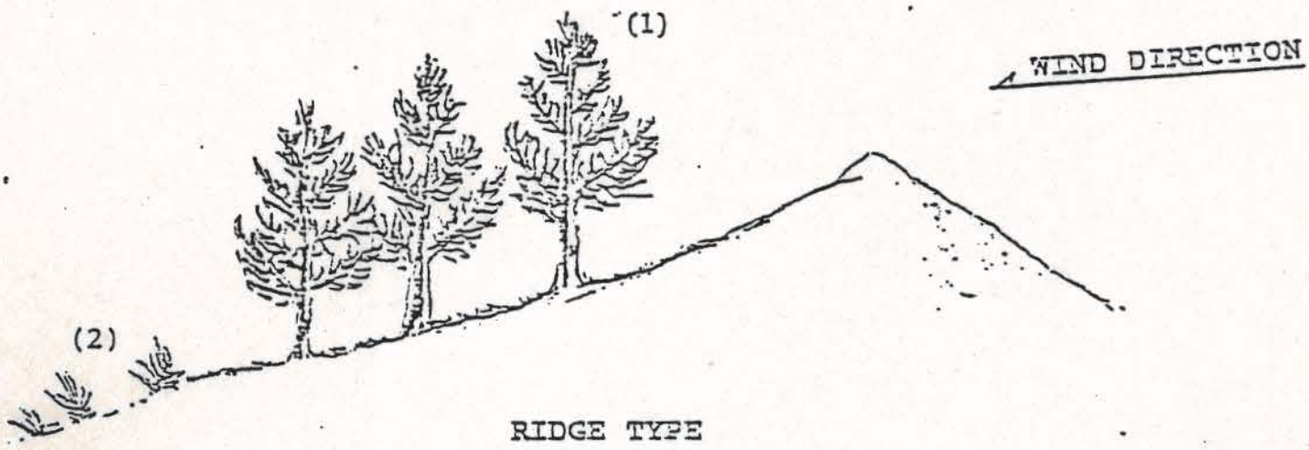
KAHOOLAWE CONSERVATION
TREATMENT LOCATION MAP
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
PACIFIC OCEAN
N
I
II
III
IV
V
VI

PROCEDURE GUIDES

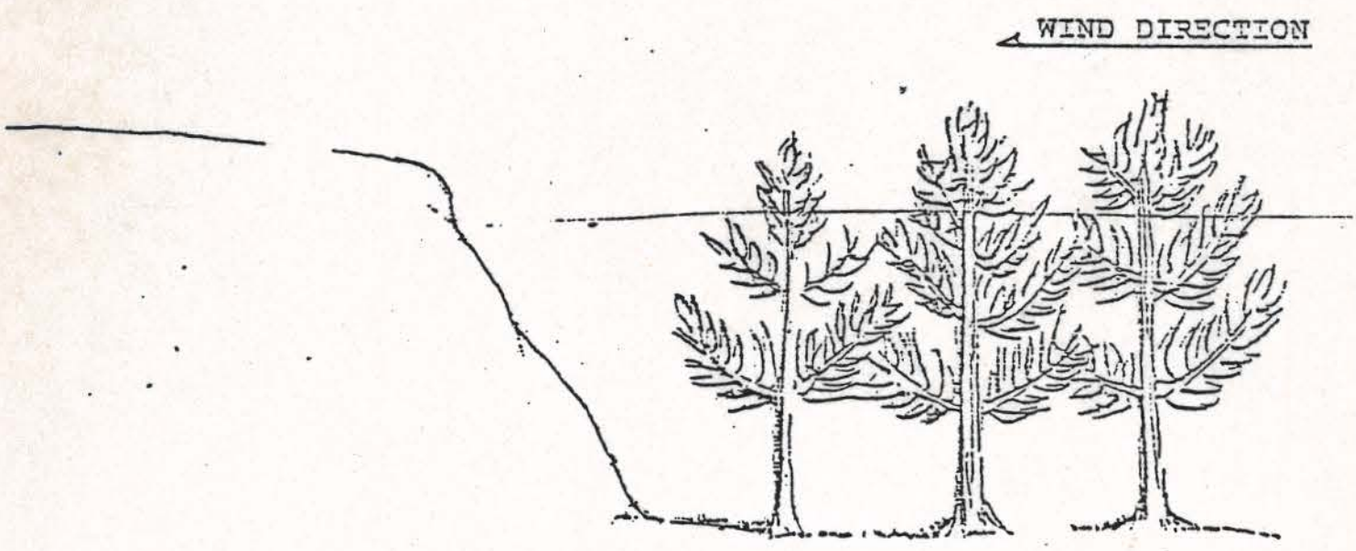
FOR

APPLYING TECHNIQUES

PROCEDURE 1.--TREE WINDBREAKS



RIDGE TYPE



TOE TYPE

LEGEND

(1) Three rows of Tamarisk trees.

(2) Strip of buffelgrass (may or may not be included in ridge-type windbreak planting).

PURPOSE

1. To reduce the force of wind.

2. To cause deposition of windblown soil and provide a media for vegetation to establish in.

(Continued)

3. To collect "fog drip" at higher elevations to improve soil moisture.

4. To provide a seed source for windblown buffelgrass seed (only in ridge type with buffelgrass planting).

PLANTING CRITERIA

1. Tamarisk trees:

   Within-row spacing - 10 feet between trees.

   Between-row spacing - 10 feet between rows.

2. Buffelgrass (single-row planting for ridge type only).

   Potted stock - clumps planted 10 feet apart in the row on leeward side of the windbreak.

PLANTING PROCEDURE

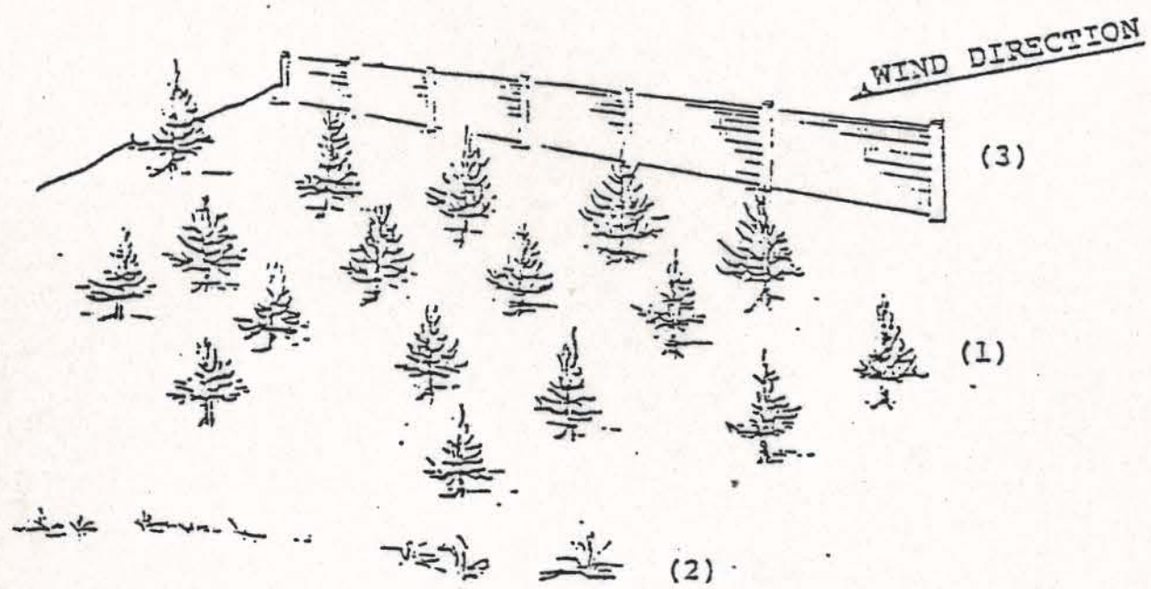
1. Lay out windbreak perpendicular to wind direction.

2. Blast holes for planting at spacing recommended above.

3. Insert two to three slow-release fertilizer tablets in each hole. Cover with about 1 inch of soil and insert the tree in the hole. Cover roots with soil material and compress soil to remove air.

4. Use same procedure as in items 1 to 3 above for potted buffelgrass plants.

PROCEDURE 2.--SOIL GRABBER - SARAN SCREEN



LEGEND

(1) Three rows of Tamarisk trees.
(2) Strip of buffelgrass.
(3) Saran wind screen, 8 to 12 inches high, tires or other suitable material.

PURPOSE

1. To cause deposition of windblown soil and to provide a media for vegetation to establish in.

2. To reduce the force of wind.

3. To collect "fog drip" at higher elevations to improve soil moisture.

4. To provide a seed source for windblown buffelgrass seed.

PLANTING CRITERIA

1. Tamarisk trees: Within-row spacing - 10 feet between trees.
   Between-row spacing - 10 feet between rows.

2. Buffelgrass (single-row planting): Potted stock - clumps planted 10 feet apart in the row on the leeward side of the windbreak.

PLANTING PROCEDURE

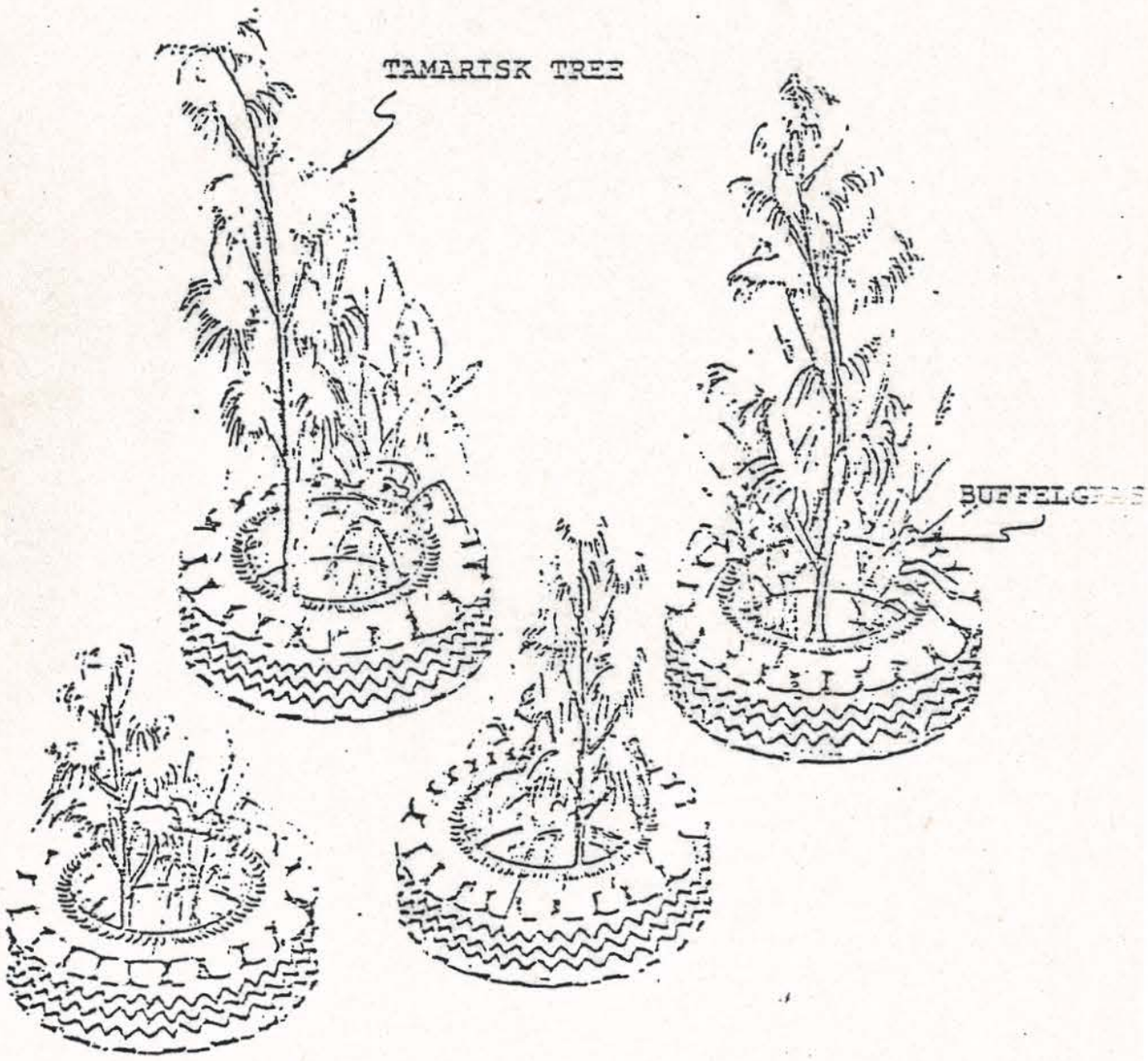
1. Lay out saran wind screen, tires or other suitable material.

2. Blast holes approximately 10 feet downwind and parallel to screen for tree planting using spacing recommended above.

3. Insert two or three slow-release fertilizer tablets in each hole. Cover with about 1 inch of soil and insert the tree in the hole. Cover roots with soil material and compress soil to remove air.

4. Use items 1 to 3 above for potted buffelgrass plants.

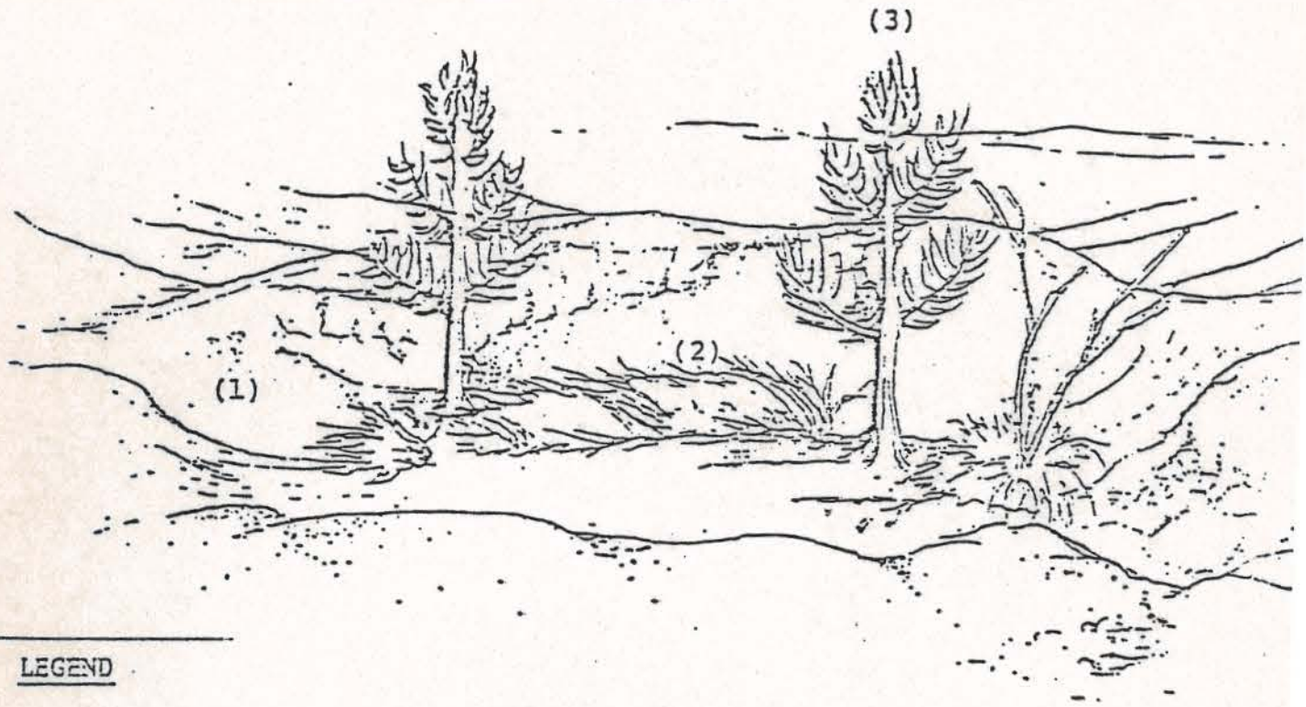
PROCEDURE 3.--SOIL GRABBER - TIRES



(3)

May be used in lieu of Saran Wind Screen

PROCEDURE 4.--SEDIMENT RETENTION CRATERS



LEGEND

(1) Blasted crater.

(2) Buffelgrass to be established.

(3) Tamarisk trees.

PURPOSE

1. To trap sediment and runoff.

2. To provide an area to establish trees and grass that is protected from the wind.

3. To stabilize small rills and gullies not more than 2 to 3 feet deep.

CONSTRUCTION CRITERIA

Craters should be approximately 10 to 20 feet in diameter and have an average depth of 2 to 3 feet.

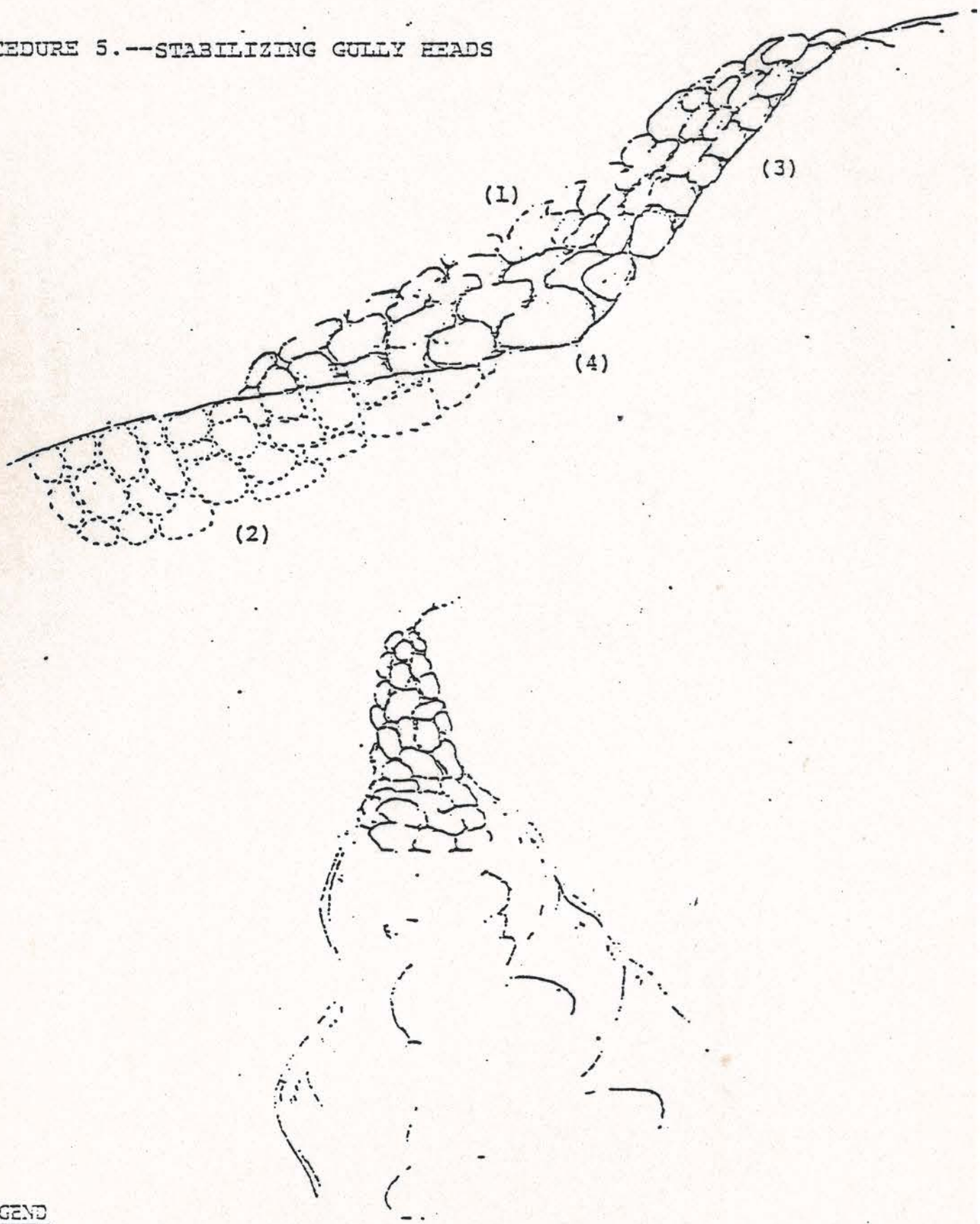
CONSTRUCTION PROCEDURE

1. Place and detonate charges to create craters at locations designated by the Soil Conservation Service technician.

2. Scatter a handful of buffelgrass seed into the crater and lightly rake it into the soil.

3. Plant two to three Tamarisk trees with two or three slow-release fertilizer tablets for each tree planted.

PROCEDURE 5.--STABILIZING GULLY HEADS



LEGEND

(1) Rock or other approved surfacing material shown in place.

(2) Core hole filled with rock or other suitable material.

(3) Gully head.

(4) Toe of gully head.

(Continued)

PURPOSE

To stabilize gully erosion caused by concentrated runoff.

MATERIALS

Rock riprap, grouting, or other available material approved by the Soil Conservation Service technician.

CONSTRUCTION PROCEDURE

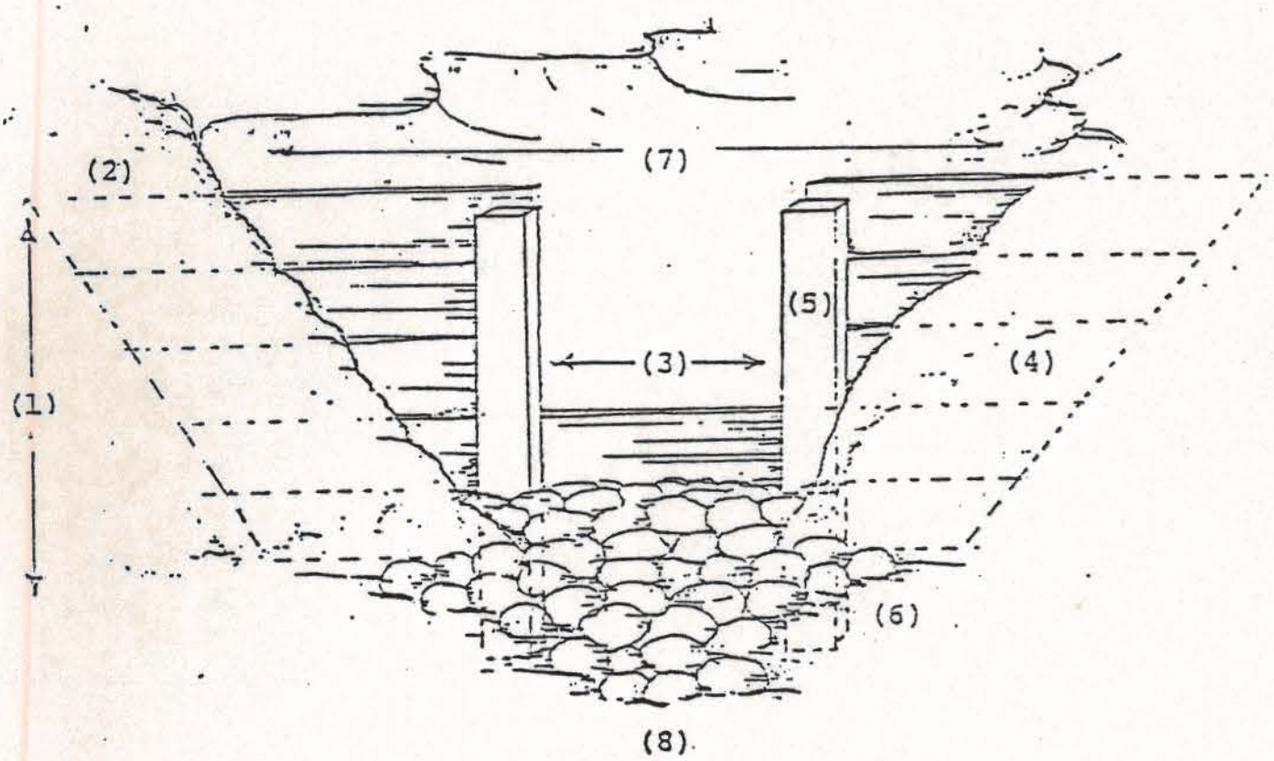
1. Blast core hole just below the toe of the gully head. The hole should be 2 to 3 feet deep and extend across the face of the toe.

2. Fill the core with rock and cover the gully head (as shown in the illustration), working from the toe to the top of the gully head. If rocks are used, they should vary in size and be wedged in place.

3. (Optional). Covering the rock with jute netting or fine mesh or wire netting will encourage deposition of sediment and provide a media for plants to establish in.

4. In some cases, it may be necessary to stabilize the rock surfacing with woven wire, netting, or grouting. This procedure should be used as recommended by the Soil Conservation Service technician.

ROCEDURE 6.--PLANK CHECK DAM



EGEND

(1) Dam height and location: The height and location of the dam will be determined by the Soil Conservation Service technician.

(2) Distance between the top of the dam and the top of the side of the gully: This distance should be at least 12 inches.

(3) Spillway size: The size of the spillway opening depends on the area contributing runoff to the dam. This will be determined by the Soil Conservation Service technician.

(4) Core trench: The sides and bottom of the dam should rest in a core trench, blasted at least 12 inches deep. To prevent undercutting, the core trench should then be filled with rock, grouting, moist compacting soil, or other protective material recommended by the Soil Conservation Service technician.

(5) Brace posts: Every plank in the dam should be fastened to each brace post with a bolt or spike.

(Continued)

LEGEND (Contined)

(6) Depth to set brace posts: Brace posts should be set in the ground at least a minimum of 24 inches.

(7) Length of the top of the dam: If the length of the top of the dam exceeds 10 feet, additional brace posts may be required as determined by the Soil Conservation Service technician.

(8) Spillway apron: The area just below the spillway on the downstream side of the dam should be surfaced with rocks, planks, corrugated sheet metal, or other suitable material recommended by the Soil Conservation Service technician.

The spillway apron should extend below the dam to a distance at least twice the height of the water drop of the spillway.

PURPOSE

1. To stabilize small rills and gullies not more than 5 feet deep.

2. ~~To cause deposition of~~ sediment to provide a suitable media for plants to establish in.

MATERIALS

Planks - 2" x 12"
Wood brace posts or iron pipe - 6" x 6"
Spikes - 5" or longer
Nuts and bolts - 1/2" or larger
Other materials approved by the Soil Conservation Service technician.

CONSTRUCTION PROCEDURE

1. Blast core trench.

2. Blast holes in core trench for brace posts.

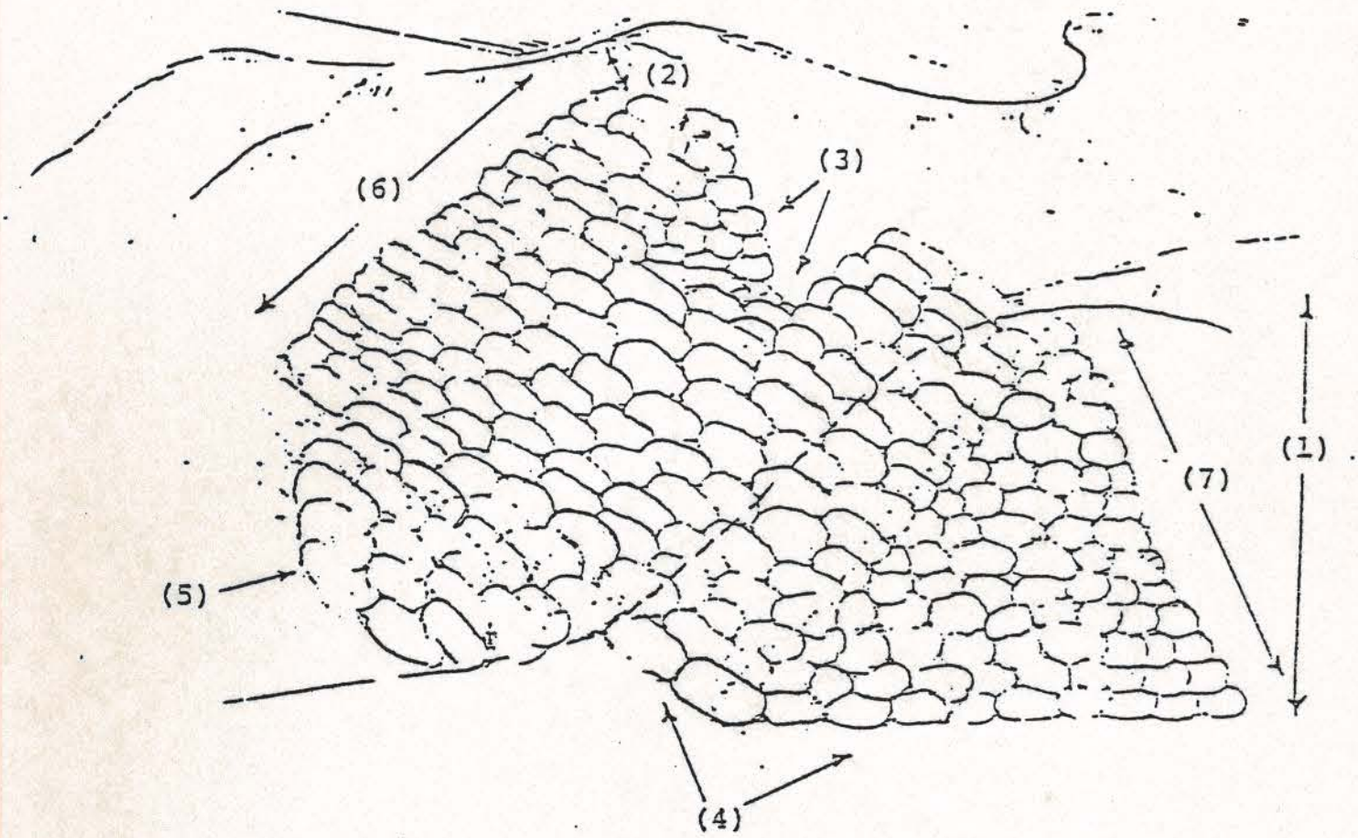
3. Set brace posts and tamp in soil, gravel, or pebbles, so that posts are firmly set in the ground.

4. Set planks in place (as shown in Procedure 1) and fasten to brace posts.

5. Fill core trench on both sides of the dam with tamped moist soil, rocks, or grouting.

6. Install spillway apron.

PROCEDURE 7.--ROCK CHECK DAM



LEGEND

(1) Dam height and location: The height and location of the dam will be determined by the Soil Conservation Service technician.

(2) Distance between the top of the dam and the top of the side of the gully will be at least 12 inches.

(3) Spillway size: The size of the spillway opening depends on the amount of land contributing runoff to the dam. This will be determined by the Soil Conservation Service technician.

(4) Core trench: The sides and bottom of the dam should rest in a core trench at least 12 inches deep.

(5) Spillway apron: The area just below the spillway on the downstream side of the dam should be surfaced with rock, corrugated sheet metal, or other material recommended by the Soil Conservation Service technician.

(6) Back slope: Side slope on the downstream side should be approximately three to one or flatter.

(7) Front slope: Side slope on the upstream side should be approximately two to one.

(Continued)

PURPOSE

1. To stabilize small rills and gullies not more than 5 feet deep.

2. To cause deposition of sediment to provide a suitable media for plants to establish in.

CONSTRUCTION CRITERIA

1. Rock of varying size should be used, so that rocks may be wedged in place.

2. Wire netting, grouting, or other fastening material should be used where determined needed by the Soil Conservation Service technician.

CONSTRUCTION PROCEDURE

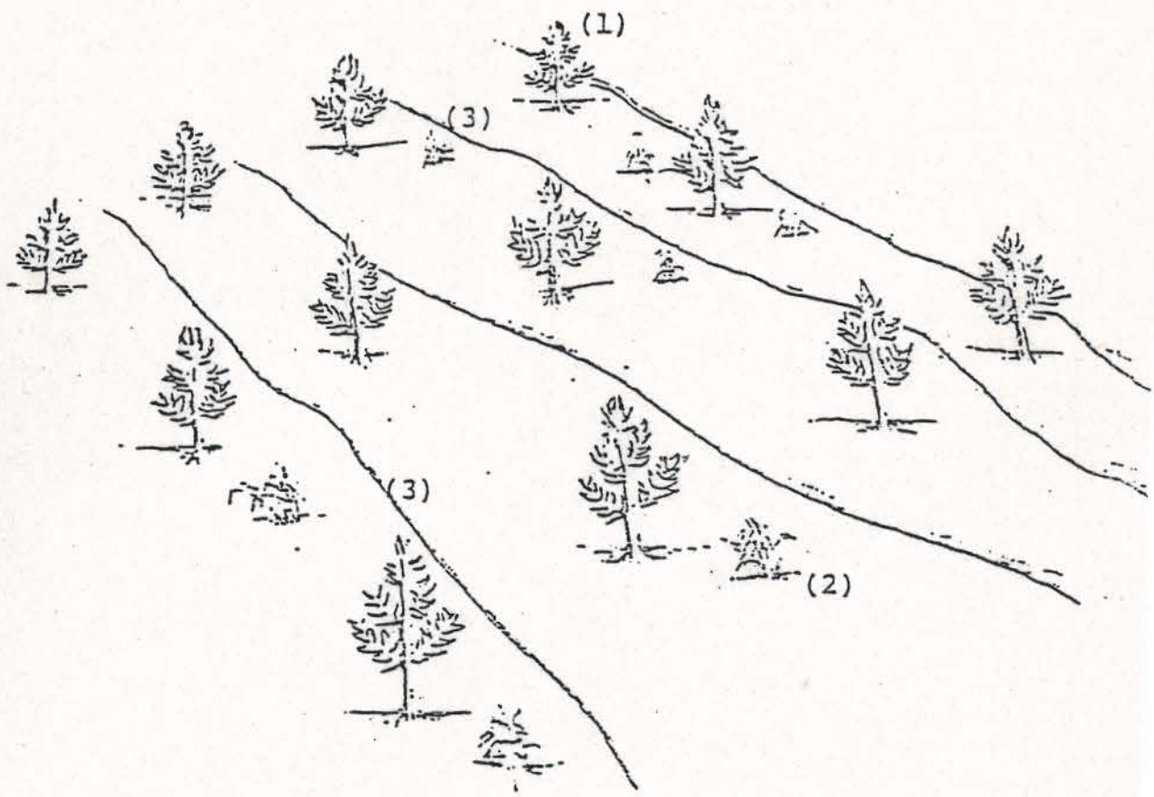
1. Blast core trench.

2. Build structure with rock according to criteria and illustration in Procedure 2.

3. Tie rock down with wire netting or other material as needed and as determined by the Soil Conservation Service technician.

4. Be sure that structure completely fills and covers the core trench to prevent under or side cutting.

PROCEDURE 8.--SPOT-TREE AND GRASS PLANTINGS



LEGEND

(1) Tamarisk trees.

(2) Potted or seeded buffelgrass.

(3) Small rills, gullies, or gully heads not more than 2 to 3 feet deep.

PURPOSE

1. To stabilize shallow rills, gullies or gully head.
2. To cause deposition of wind- and water-borne sediment and provide a media for vegetation to establish in.
3. To provide a seed source for both wind- and water-borne seeds.

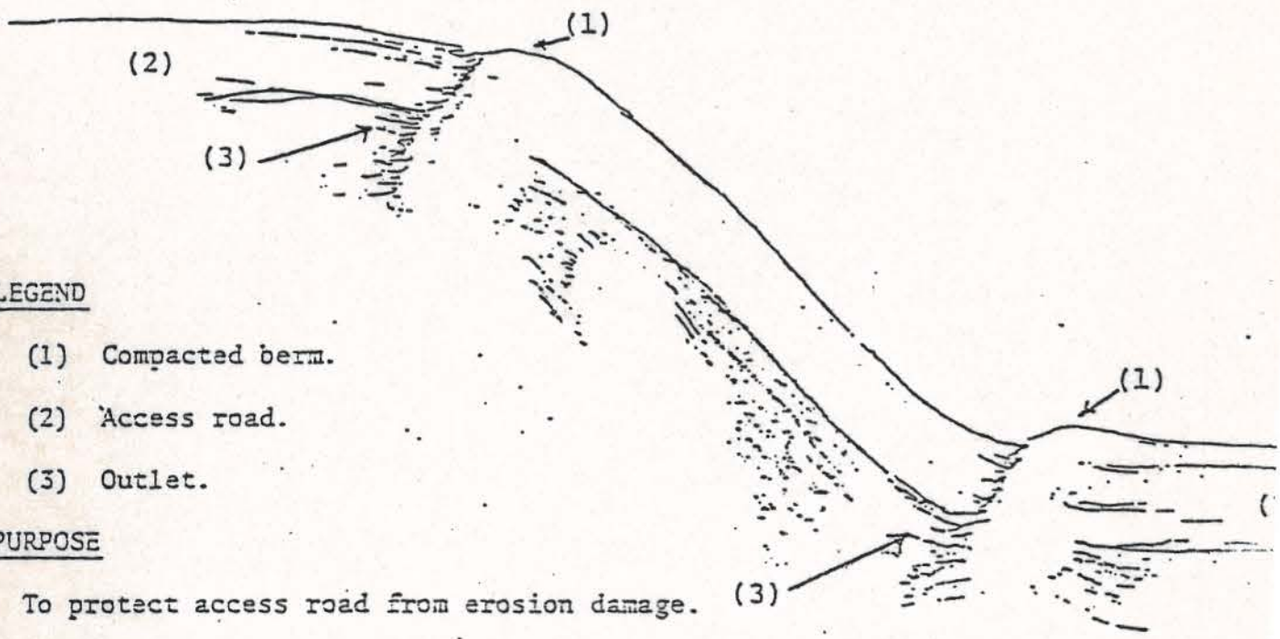
PLANTING CRITERIA

Location of tree and grass plantings to be determined on site by the Soil Conservation Service technician.

PLANTING PROCEDURE

Use same procedure as in windbreak planting (Procedure 1).

PROCEDURE 9.--ACCESS ROAD EROSION CONTROL



LEGEND

(1) Compacted berm.

(2) Access road.

(3) Outlet.

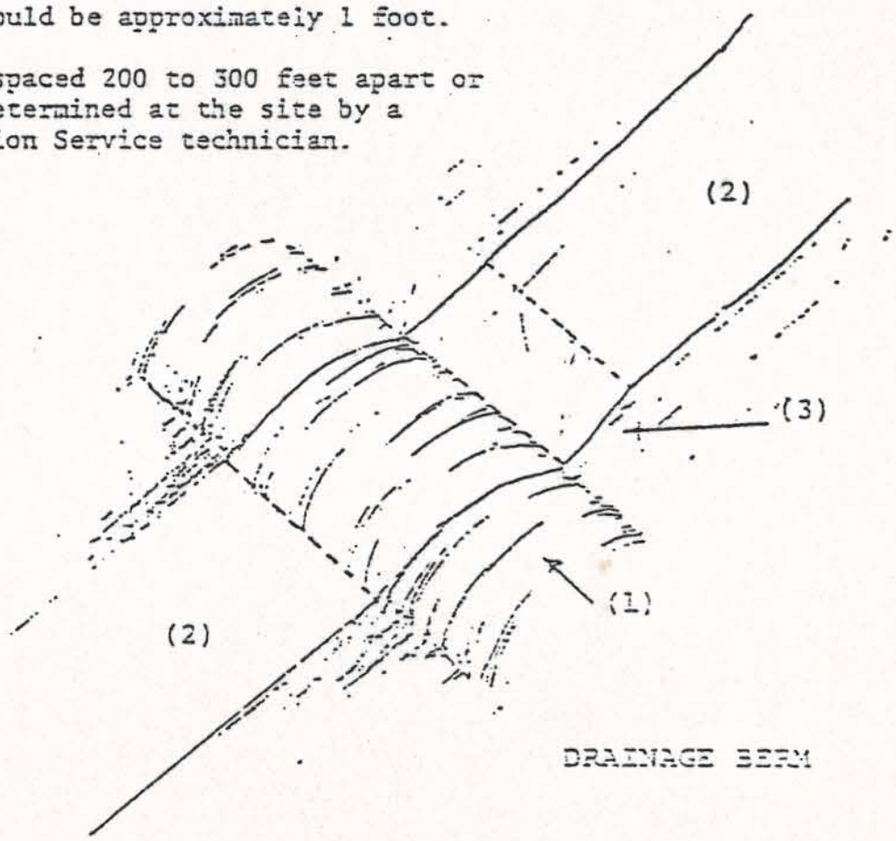
PURPOSE

To protect access road from erosion damage.

CONSTRUCTION CRITERIA

1. Berm height should be approximately 1 foot.

2. Berms will be spaced 200 to 300 feet apart or at locations determined at the site by a Soil Conservation Service technician.



DRAINAGE BERM

PROCEDURE 10.--MANAGEMENT AND USES OF BUFFELGRASS (Cenchrus ciliaris)[1/]

DESCRIPTION

Buffelgrass is a bunch to rhizomatous grass 1/2 to 4 feet tall, with a tough knotty crown. Roots are dense and long. Leaves are green to bluish-green in color, 3 to 12 inches long, and 1/8 to 1/4 inch wide. Old plants become stemmy with harsh leaves. Flowering stems extend beyond the leaves, are cylindrical, upright to slightly drooping, purplish, and 2 to 4 inches long. Individual flowers appear singly or clustered (2 to 3) and are surrounded by numerous bristles. The 3/8- to 3/4-inch long bristles are fused at the base.

Buffelgrass is a highly variable species with many strains. Some have narrow leaves, others much wider foliage. Some are distinctly upright, while others are semiprostrate. Some varieties produce abundant seed, while others are poor seeders. Buffelgrass has about 80,000 seeds per pound in the bur. The seed is widely spread by wind and by animals.

The following are recommended for use on Kahoolawe:

'T-4464' - A common commercial buffelgrass out of Texas and the southwest; adapted to elevations below 1,000 feet.

'Biloela' - A tall blue-green buffelgrass from Australia; adapted to elevations below 1,500 feet.

A local variety (HA-333) would also do well; however, seed is not commercially available.

ADAPTATIONS

Climate - Buffelgrass will grow well in areas with 10 to 30 inches of annual rainfall, at elevations ranging from sea level to 3,000 feet. It is well-suited to hot, dry sites and can withstand extended periods of drought.

Soils - Buffelgrass makes good growth on a wide variety of soils.

Fire - Buffelgrass will normally re-establish itself after a rain if it should be burned off.

1/ Not to be confused with buffalograss (Stenotaphrum secundatum).

USES

Erosion Control - It provides good ground cover for areas of low rainfall, prevents erosion, and is used for stabilizing eroding soils.

ESTABLISHMENT

Buffelgrass is readily established from seed or vegetative material planted during rainy periods. The suggested seeding rate is from 1 to 3 pounds per acre.

LAND TREATMENT SUMMARY[1/]

Land Treatment	Unit	TREATMENT AREA I	II	III	IV	V	Total
Gully Head Structure	No.	35	113	53	59	40	300
Check Dam	No.	74	193	95	115	0	477
Soil Grabbers	Ft.	6,800	3,100	10,900	5,300	1,800	27,900
Sediment Retention Crater	No.	50	4,000	2,700	0	120	6,870
Windbreaks	Ft.	102,000	2,500	3,000	19,000	7,000	133,500
Spot-tree Planting	No.	0	1,320	1,155	2,380	0	4,855

1/ No sites have been selected at this time in Treatment Area VI since this area is the lowest priority for treatment. See page 5 for recommended treatment.

LAND TREATMENT BY TREATMENT AREA

Location*	Land Treatment	Amount
	Area I	
1	Gully head structures	20 ea.
	Check dams	30 ea.
	Soil grabbers	2,400 ft.
2	Gully head structures	15 ea.
	Check dams	20 ea.
	Sediment retention craters	50 ea.
3	Tree windbreaks between existing vegetation	62,000 ft.
	Soil grabbers	400 ft.
	Check dams	24 ea.
4	Tree windbreaks between gulch and grass areas	40,000 ft.
5	Soil grabbers	4,000 ft.
	Area II	
1	Soil grabbers	3,100 ft.
	Gully head structures	10 ea.
	Check dams	20 ea.
2	Gully head structures	3 ea.
	Check dams	8 ea.
3	Spot-tree planting (3 acres) 55 trees/1/8 acre	1,320 tree.
	Gully head structures	25 ea.
	Check dams	40 ea.
4	Tree windbreaks (3 rows - 10 x 10 around crater rim)	2,500 ft.
5	Gully head structures	50 ea.
	Sediment retention crater (45/acre)	4,000 ea.
	Check dams	75 ea.
6	Gully head structures	25 ea.
	Check dams	50 ea.

*Location number corresponds to number on conservation treatment location map.

LAND TREATMENT BY TREATMENT AREA (cont'd)

Location*	Land Treatment	Amount
	Area III	
1	Sediment retention craters (45/acre - 60 acres)	2,700 ea.
2	Gully head structures	10 ea.
	Soil grabbers	1,800 ft.
	Check dams	15 ea.
3	Check dams	20 ea.
	Gully head structures	35 ea.
	Soil grabbers	2,000 ft.
4	Soil grabbers	5,000 ft.
5	Check dams	10 ea.
	Spot-tree planting (.25 acre)	110 trees
6	Gully head structure	1 ea.
7	Check dams	20 ea.
	Soil grabbers	1,500 ft.
8	Windbreaks	3,000 ft.
9	Gully head structures	5 ea.
	Spot-tree planting (.25 acre)	165 trees
10	Check dams	30 ea.
11	Gully head structures	2 ea.
	Soil grabbers	600 ft.
12	Spot-tree planting (2 acres)	880 trees

*Location number corresponds to number on conservation treatment location map.

LAND TREATMENT BY TREATMENT AREA (cont'd)

Location*	Land Treatment	Amount
	Area IV	
1	Soil grabbers	1,000 ft.
	Gully head structures	25 ea.
	Tree windbreaks	2,000 ft.
	Spot-tree planting (1 acre)	400 trees
	Check dams	45 ea.
2	Gully head structures	30 ea.
	Tree windbreaks	3,000 ft.
	Check dams	50 ea.
3	Tree windbreaks	14,000 ft.
4	Spot-tree planting (3.5 acres)	1,540 trees
5	Gully head structures	2 ea.
	Check dams	10 ea.
	Spot-tree planting (0.5 acre)	220 trees
6	Soil grabbers	4,000 ft.
7	Gully head structure	1 ea.
8	Gully head structure	1 ea.
	Soil grabber	300 ft.
9	Check dams	10 ea.
	Spot-tree planting (1/2 acre)	220 trees
	Area V	
1	Sediment retention craters	100 ea.
	Gully head structures along the crater rim	10 ea.
2	Windbreaks (along the target area boundary) mechanical (oil drums or similar material)	2,000 ft.
3	Soil grabbers	1,000 ft.
	Windbreaks	3,000 ft.
4	Soil grabbers	800 ft.
	Gully head structures	30 ea.
	Windbreaks	2,000 ft.
5	Sediment retention craters	20 ea.

*Location number corresponds to number on conservation treatment location map.