LAND PLANNING REPORT

LAND MANAGEMENT UNIT NO. 3

January 1938

Study Group "B"

Approved:

Submitted:

Daniel G. Anderson
Junior Range Examiner

I N D E X

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LAND PLANNING REPORT
LAND MANAGEMENT UNIT NO. 3

PART ONE - BASIC DATA

I. LAND MANAGEMENT UNIT NO. 3:

A. INTRODUCTION:

Field work connected with the Land Management Surveys was conducted between December 1, 1936, and April 15, 1937. Field surveys were delayed by severe snowstorms and the fact that large areas were involved in proposed boundary changes.

Personnel of Study Group "B" making the land Management Surveys in the area include:

Section of Agronomy

Howard M. Ivory - - - - - - - - Agricultural Aide

Section of Biology

Gale Monson - - - - - - - - - - Junior Biologist

Section of Conservation Surveys

Ray H. Kerr - - - - - - - - - - - Junior Soils Surveyor

Lucien A. Hill - - - - - - - - - Junior Soils Technologist

Lewis K. Armstrong - - - - - - - Asst. Soils Surveyor

Otto A. Sonntag - - - - - - - - Junior Soils Surveyor

Howard F. Johnson - - - - - - - - Junior Soils Surveyor

Section of Engineering

Cecil L. Moyes - - - - - - - - - Engineering Aide

Section of Human Surveys

Gordon Page - - - - - - - - - Under Agricultural Aide

Haske Naswood - - - - - - - - Under Agricultural Aide

Dannie Bia - - - - - - - - - Under Agricultural Aide

Tom Ettson - - - - - - - - - Under Agricultural Aide

Section of Range Management

Daniel G. Anderson - - - - - Junior Range Examiner

Albert Sombrero - - - - - - - Under Agricultural Aide

Edison Bowman - - - - - - - Under Agricultural Aide

Section of Woodland Management

George A. Herion - - - - - - Junior Forester
(Chief of Party)

Branch reports for the area were written by the following:

Agronomy - - - - - - - - - H. M. Ivory

Biology - - - - - - - - - Gale Monson

Conservation Surveys - - H. L. Thomas

Engineering - - - - - - - - Cecil L. Moyes

Human Surveys - - - - - -

Range Management - - - - D. G. Anderson

Woodland Surveys - - - - George Herion

B. GEOGRAPHIC FEATURES:

1. Description:

a. Location and Political History:

"Land Management Unit No. 3, with headquarters at Tuba City, Arizona, is located in the extreme western part of the Navajo Indian Reservation and comprises the western part of the Western Navajo jurisdiction; the ~~western~~ boundary of the Reservation forms the south boundary of the Unit. On the west, the Tusayan National Forest, the Grand Canyon National Park and the Colorado River form the boundary. The Unit lies in Coconino and Navajo Counties, Arizona, roughly between 110 30' ± 111 45' west longitude and 35 30' ± 37 15' north latitude."

A large portion of this area lying immediately around Tuba City and to the north became part of the Reservation by an Executive Order January 28, 1900. The area lying within the Unit east of 111° west longitude became Reservation by Executive Order December 16, 1882. A smaller area, bordering Marble Canyon and west of Bodaway House, became Reservation by an Act of Congress May 23, 1930. This Act also included the area comprising Gray Mountain. An area between Gray Mountain and the Little Colorado River became Reservation by an Executive Order January 19, 1918. The final area to be added to the Reservation in this locality was the Campbell-Francis area, by an Act of Congress June 14, 1934. The entire area lying within Unit No. 3 is tribal land and Indian allotments with the exception of the few privately owned lands at

Cameron, Tuba City and in the Campbell-Francis area. Private land comprises 9300 acres; patented Indian allotments on the Reservation, 3000 acres; and patented Indian allotments bordering the southern portion of the Unit, 920 acres.

b. Area and Boundaries:

The area of Land Management Unit No. 3 as outlined and compiled from the range type maps is 1,760,378 surface acres. The original boundaries included 1,422,000 acres, but due to various existing conditions, several boundary changes were proposed. The boundaries as originally set were, in general, as follows:

Boundaries

Beginning at the junction of the Little Colorado and Colorado Rivers, the boundary extended north along Marble Canyon approximately eighteen miles; thence east across Cedar Ridge to Willow Springs and Moenave Demonstration area; thence northeast to Preston (Red) Mesa; thence to the southeastern point of White Mesa; thence east to the Moencopi drainage on Black Mesa; thence southwest along the Moencopi drainage to the 111th meridian; thence south along the meridian approximately twenty-five miles to Sand Springs Trading Post; thence west along the drainage divide to the Little Colorado River at Black Falls; thence west and north along the Reservation boundary to the point of beginning. Boundary changes were proposed at Cedar Ridge, Howell Mesa, Dinnebito and Black Falls.

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(1) Boundary Changes:

A discussion of the various boundary changes, giving acreage, carrying capacity of the areas affected, and reasons for proposing the changes, follows:

(a) Bodaway House-Cedar Ridge Change:

This change added to Unit No. 3 the area lying north of the original Unit boundary, east of Marble Canyon, west of Echo Cliffs and south of Crooked Ridge, an area comprising approximately 485,000 surface acres, 40,000 forage acres and a carrying capacity of 16,000 sheep units. The area originally was in Land Management Unit No. 1. Reasons for proposing this change were numerous. First, the proposed boundary falls on natural topographical features, Echo Cliffs being inaccessible from Lee's Ferry to the Gap with the exception of trails at Navajo Ridge, Cedar Ridge and Bitter Seeps. Crooked Ridge forms a natural boundary although not inaccessible. Second, from an administrative standpoint, the area involved could be handled more easily from Tuba City than Kaibito as headquarters, there being a good road from Tuba City to the area. Third, livestock usage in the area indicated an important need for the change. Indians in and around Crooked Ridge, recognizing this as a boundary, very little livestock movement across the boundary is to be expected from the group. In the past there has been some shift of livestock south of Crooked Ridge by Kaibito Indians during the summer for water. This condition has been somewhat corrected by

the construction of drilled wells north of Crooked Ridge. Fourth, cultivated land at Tuba City and Moenave tend to draw Indians from the Bodaway House, Cedar Ridge and the Gap during the farming season. Fifth, livestock water in the Bodaway House area is of a temporary nature and a seasonal shift to permanent supplies at the Gap and Tuba City results.

Livestock usage in the vicinity of Cedar Ridge extends as far north as Bitter Seeps. The area north of that within the proposed change is used by the Kaibito population for the purpose of salting sheep on salt bush. However, there are enough Cedar Ridge cattle and horses in the area yearlong to more than properly utilize the available forage. Administratively, this small area is accessible to the supervisor of Land Management Unit No. 1 by means of a trip of more than one hundred miles, the supervisor having to go to Tuba City or the Gap to cross Echo Cliffs. It was, therefore, deemed advisable to extend the boundary north of Bitter Seeps to Lee's Ferry along Echo Cliffs.

(b) Red Lake-Black Mesa Change:

This change is an exclusion from Unit No. 3. The boundary as proposed would extend from Red Mesa to Little White Mesa and thence south to the Moencopi drainage and would exclude approximately 385,000 surface acres, 27,790 forage acres, and a carrying capacity of 11,116 sheep units yearlong in the vicinity of Red Lake, Cow Springs, and Black Mesa, from Unit No. 3.

Of this area, approximately 205,500 acres in the vicinity of Red Lake, Cow Springs and Black Mesa would be added to Land Management Unit No. 1. The remainder, falling principally on Black Mesa, would be added to Land Management Unit No. 2.

Reasons for proposing this change were principally usage and administration. The area lying north of the proposed boundary was within the Red Lake Chapter boundary. The development of permanent water in the vicinity of Red Lake has caused Red Lake usage to extend farther west than the original chapter boundary line. The Indians residing within this area would prefer to be handled administratively from Kaibito rather than Tuba City primarily because of a seasonal shift of livestock from this area to winter range around Antelope Reservoir and the Coppermine in Unit No. 1. There is also a counter shift of people during the summer months from Kaibito to the farming area around Red Lake and Cow Springs. Red Lake is located much nearer to Kaibito than Tuba City and the area could more easily be handled from Kaibito.

(c) Howell Mesa Change:

This area is an addition to Unit No. 3 from Unit No. 4. It includes the area lying east of the original Unit boundary, south of the Moencopi Wash, west of Dusty Valley, and north of the Dinnebito Wash. An area of 176,031 acres with carrying capacity of 7,994 sheep units yearlong is affected.

This change was originally proposed by Study Group "C" while preparing plans on Unit No. 4, and is concurred with by

this group, based on the data obtained in the area.

Briefly to review the reasons for making the change, the usage is primarily from Tuba City rather than Unit No. 4, the area is more accessible to Tuba City than Pinon, and the proposed boundaries fall on natural topographic boundaries.

(d) Dinnebito Wash Change:

This area is a continuation of the Howell Mesa change and would add to Land Management Unit No. 3 the area north of Sand Springs Trading Post and west of the Dinnebito Wash. An area of 15,380 surface acres and a carrying capacity of 548 sheep units yearlong would be excluded from Unit No. 5. This change was made for the same reasons of usage and administration as the Howell Mesa change.

(e) Black Falls Change:

This change adds to Unit No. 3, 34,575 surface acres, with a carrying capacity of 1,134 sheep units yearlong, which were originally in Unit No. 5. The area is delineated by the original boundary line of Unit No. 3 on the north, the Little Colorado River on the south and west, and Rock Springs Rim on the east. By obtaining field data from Mr. McKinney while studying Unit No. 5, it was felt that this boundary would more correctly split Leupp and Tuba City usage.

Present boundaries for Unit No. 3, taking into consideration the boundary changes, are as follows:

Beginning at the junction of the Colorado and Little Colorado Rivers, the boundary extends north along Marble Canyon to Lee's Ferry; south, along Echo Cliffs to the Gap Trading Post; north and east, along the south boundary of Unit No.1 along Crooked Ridge, Red Mesa, Little White Mesa and Moencopi Wash to Dusty Valley; thence south along the west boundary of Units Nos. 4, 6 and 5 along Dusty Valley to the Dinnebito Wash at the Standing Cottonwood Tree agricultural area; along the Dinnebito Wash to Sand Springs Trading Post, along the Kloy-e-chee rim and Rock Springs rim to the Little Colorado River; thence northwest along the Little Colorado River approximately eleven miles to the south Reservation boundary following along said boundary to the point of beginning (See map).

2. Physical Geography:

a. Climatology:

Elevation of the Unit varies from approximately 4200 feet on the Little Colorado River, 4900 feet at Tuba City, to 6500 feet on Gray Mountain. The largest portion of the area lies from 4500 to 5000 feet above sea level. Climatological stations located within the Unit are at Tuba City and Lee's Ferry. Both stations will give a relatively accurate picture of climate over the Unit as a whole because of its general uniformity throughout, with the exception of a small area on Gray Mountain. Temperature at Tuba City varies from 15° F below zero to 108° F above. Rainfall

records at Tuba City give the annual average precipitation of approximately seven inches, varying from three inches as a minimum to twelve inches as a maximum. The records are incomplete for twenty-nine years, during the period from 1897 to 1935.

Killing frosts have been known at Tuba City as early as September 5, with the average growing season extending from April 22 to September 19, or 179 days.

Prevailing winds of the area are from the southwest. Since the terrain is principally rolling hills without forest, the wind has a clear sweep at the area and in many cases is a leading factor in the degree of wind ercsion.

There are no complete evaporation records available for the Unit. However, because of the amount of wind, the high temperatures and the low relative humidity, evaporation can be expected to exceed ninety inches annually.

b. Soils:

The soils of Unit No. 3 are derived from reddish brown Morrison and Wingate sandstones in the eastern and northeastern portion, the reddish brown or maroon Chin Lee and Moencopi shales in the central portion; and the grayish brown and the Kaibab limestone in the western portion. Soils derived from igneous rock occur in the southern portion of the Unit and in a limited area immediately north of Cameron. The parent materials of the various soils in the Unit have imparted different characteristics which influence their productive value and susceptibility tc

erosion. Soils derived from sandstone formations lying principally in the eastern half of the Unit are coarse-textured and are very susceptible to wind erosion, especially upon the depletion of vegetative cover. These soils are, by their nature, very good in water penetration, but their water-retention value is low. The soils of the central portion of the area, derived primarily from Moencopi and Chin Lee shales, are fine-textured, heavy, and have a low water-penetration value. High run-off may be expected from this area. Productivity of these soils is rather low.

The soils derived from the Kiabab limestone, although shallow and rocky, have a rather high water-holding capacity and good water-penetration qualities. In classifying the soils of the Unit, various factors have to be considered in order to arrive at any applicable classification. Erosion, permeability, water-holding capacity, and alkali content all affect the classification into which the various soils are placed. The soils have been classified as Grades A to E range soils, taking into account these factors, and any one factor may be a determining basis for placing a soil class into a grade lower, other conditions being equal. This is especially true of soils derived from the Kiabab limestone, which have been classified as Grade B or C range soils because of a shallow soil cover, even though the soils are at present of high productive value and with good permeability and water-holding capacity. A description of the classification and productivity

of the various range soils in the area and the delineation of agricultural soils will be found in the discussion of range and farming resources of the area. For the most part, the alkali content of the soils in this area is rather low. The exceptions to this occur in soils derived from the Moencopi and Chin Lee shales and in various alluvial valleys throughout the Unit. In many cases, the alkali content in restricted areas has caused the development of vegetation of low carrying capacity and a sparse enough cover to increase the erosion potential.

Soils, on the whole, for the area have a high value for construction purposes. A detailed analysis of soils for any given project, however, is recommended before actual construction takes place. Limited areas of high alkali content and increased dispersion of the soil must be carefully watched when considering construction. At the Moenave Demonstration Area, for instance, a large number of the structures already completed have proved unsuccessful because of soils characteristics. Piping holes, due to a dispersed soil have caused a number of structures to wash out with practically no head of water behind them.

c. Erosion:

Extremes in erosion conditions are exhibitied in this Unit and vary from a slight erosion in the Kiabab and Springerville series, to the very severely eroded soils of Todilto and Tolani series, some of which are essentially destroyed. Soil and climate

both contribute to an environment fundamentally donducive to erosion. A low rainfall belt persists throughout the entire Unit, with the exception of Gray Mountain. This is a controlling ecological factor in the vegetation that is predominant. Heavy, impervious soils in the shale area with steep slopes contribute to excessive, rapid run-off. Precipitation is primarily in the nature of torrential thunderstorms also tending to increase the amount and rapidity of run-off. As a result, excessive sheet and gully erosion are present.

Wind in the area is a very important contributing factor to erosion, especially on the light-textured soils derived from the various sandstone formations. The entire area is open grassland or browse and is not protected from the ravages of wind. In all the area included in the Moencopi plateau, Coal Mine Mesa and Tuba City plateau, sand dunes, varying from twelve to thirty-six inches and in many cases more, in depth, are common. Active sand dunes are present in the overstocked area immediately adjacent to Tuba City. In many cases, dunes are rapidly advancing on agricultural land or permanent water supplies. The principal cause of the accelerated wind erosion has been an undue concentration of livestock with the consequent depletion of vegetation and the disturbing of natural soil cover. Corrective measures in this regard would include the proper stocking of the range resources with a possible deferred and rotation grazing system, so as to allow the return of the natural vegetative cover

and thus protect the area. The evidence of such a system is exemplified by the Moenave Demonstration Area. Whereas Tuba City was severely disturbed by the moving of large amounts of sand into the town during the spring wind storms, since the completion of the Demonstration Area such a movement of sand has been noticeably reduced.

Erosion conditions in the central portion of the area are severe, due to a heavy, impervious soil, steep slopes and rapid run-off, together with a very sparse vegetative cover. However, because of a lack of water penetration, recovery in the area will be very slow and it is felt that the area never would support abundant vegetative cover.

Erosion in all the area occupied by the Kiabab limestone formation is slight, due primarily to a rather dense vegetative cover and high water penetration. Corrective measures in this area consist, primarily, of stocking the range to carrying capacity, so that the vegetative cover will not be destroyed to the extent that active erosion becomes a problem.

d. Geology:

In a presentation of geological information for this area, it must be borne in mind that time was a limiting factor in making the field survey and that only geologic formations in general were mapped for the area. This Unit comprises the central portion of the Painted Desert physiographic sub-division, the southern part of the Kiabab plateau sub-province, and

practically the entire Moencopi plateau physiographic sub-province. The Unit includes formations ranging from the Upper Permian time to the Upper Cretaceous. In general, the older formations lie along the western portion of the Unit and the younger formations to the east. The area has been divided into four sub-areas for reasons of clarity in describing the various formations.

(1) Red Lake Area:

In the Red Lake sub-district, the principal formation is the Navajo sandstone. It comprises nearly all the area lying north of the Moencopi Wash and east of Echo Cliffs. A very light, sandy-textured soil is produced from this formation.

(2) Little Colorado area:

The Little Colorado sub-district lies to the west of Highway 89 and north of the Little Colorado River. The area is comprised primarily of the Kiabab limestone, which forms a belt adjacent to the Little Colorado River and Marble Canyon. The Shinarump conglomerate forms a large area lying immediately east of the Kiabab limestone and extends nearly to Highway 89. Dispersed throughout both the Kiabab limestone and the Shinarump are exposed areas of the Moencopi shale. The Chin Lee formation appears in a small area to the west of High 89. Igneous rocks are present in a small area immediately around Shadow Mountain. Shadow Mountain, an extinct volcano, is estimated to be rather recent.

(3) Gray Mountain Area:

The Gray Mountain sub-district occupies all of the area south of the Little Colorado River and is composed primarily of Kiabab limestone. The area is marked by numerous faults, especially in the Gray Mountain region where the area is involved in the Gray Mountain monocline. A large area of Moencopi shale is present immediately south of Cameron and extends westward to Poverty Tank. Lava flows from the San Francisco Mountain volcanic field extend northward and reach the southern portion of the area. A rather large flow extended down Tappan Wash and crossed the Little Colorado River before it was cut to its present depth.

(4) Painted Desert - Coal Mine Area:

The Painted Desert-Coal Mine Mesa area includes all of the area east of Highway 89 and south of the Moencopi Wash. This area includes all formations from the Chin Lee to the Mancos shale of the Upper Cretaceous Age. The Chin Lee formation includes a large area immediately east of Highway 89 and represents the three divisions of the formation. Large amounts of petrified wood are to be found in this area. The Wingate sandstone is present only in a narrow strip around the base of Ward Terrace. The Kayenta formation immediately overlies the Wingate sandstone and represents a formation approximately seventy-five feet thick. The Navajo sandstone overlies the Kayenta formation and is distinguishable from all formations except the Morrison. It is

present at Tuba City and follows the Kloy-e-chee rim southward. It forms a portion of Coal Mine Mesa, but its contact with the Morrison is indistinguishable. The Morrison is a chalky, white sandstone and comprises the entire Coal Mine Canyon. It is overlaid by the Mancos shale. which is exposed on the rim of Coal Mine Mesa and the slopes of Howell Mesa.

The only coal deposits in the area are found in the Mancos shale along Coal Mine Canyon.

e. Topography:

Topography of the Unit varies from steep, broken, rough hillsides or canyons to level or rolling mesa tops and valleys. Gray Mountain, Kloy-e-chee, Echo Cliffs, Lower Basin and Lee's Ferry exhibit the former. Coal Mine Mesa, Moencopi Plateau, Willow Springs Wash and the Bodaway House area constitute the larger portion of rolling terrain in the area.

d. Drainage and Run-off:

The area lies entirely within the Colorado River watershed and is drained by the Little Colorado River through the Dinnebito Wash and Moencopi drainage. High run-off may be expected from approximately three-fourths of the area, characterized by steep slopes and impervious soils. Large areas on Coal Mine Mesa and the Moencopi Plateau are very sandy and little or no run-off may be expected from these areas. The watershed value of the land is especially important on Howell Mesa and the Painted Desert area north of Cameron.

3. Vegetation:

a. Vegetative Zones:

Vegetation in this Unit is typical of the Upper Sonoran zone. In the bottom of a few canyons, mesquite and cactus, typical of the Lower Sonoran zone, were found but in such limited quantities as to be of negligible importance.

b. Vegetative Types:

The following table graphically presents the abundance and importance of the various vegetative types within the Unit:

TableI Vegetative Type Summary

Type	Surface Acres	Percent of Area	Forage Acres	Percent of CC*	C.C. SYL**
1. Grassland	396,881	22.55	51,420	42.86	20,568
4. Sagebrush	131,344	7.46	15,499	12.92	6,200
5. Browse	853,799	48.50	47,496	39.59	18,998
7. Waste	126,053	7.16			
8. Barren	158,862	9.02			
9. Woodland	89,362	5.08	5,556	4.63	2,222
Cultivated	3,431	0.19			
Miscellaneous (Townsite, etc.)	646	0.04			
Total - -	1,760,378	100.00	119,971	100.00	47,988

* CC - Carrying Capacity
** SYL - Sheep units yearlong

From a study of the foregoing table it is seen that nearly 1/2 of the area is browse, 1/6 is waste or barren, 1/5 is grassland, and 1/20 is woodland. Carrying capacity figures show a different relationship. Whereas sagebrush and grassland comprise less than 1/3 of the total area, they account for more than 1/2 the carrying capacity, showing a relatively higher average carrying capacity than browse or woodland. Cultivated land makes up only 1/5 of 1% of the area. Agronomic figures are considerably less, 2177 acres, and are based on land actually tilled, whereas the above figures include all land under fence, a portion of which is farmed.

c. Vegetative Species:

A list of the more important vegetative species, listed wherever practical in order of importance, follows:

GRASSES

Blue grama	Bouteloua gracilis
Galleta grass	Hilaria jamesii
Alkali sacaton	Sporobolus airoides
Sand dropseed	Sporobolus cryptandrus
Black grama	Bouteloua eriopoda
3-awn	Aristida spp.
Six-weeks grama	Bouteloua barbata
Buffalo grass	Schleropogon spp.
Spiny muhley	Muhlenbergia pungens
Indian Rice Grass	Oryzopsis spp.

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BROWSE

Chamise	Atriplex canescens
Snakeweed	Gutierrezia spp.
Big Sage	Artemizia tridentata
Sand sage	Artemizia filifolia
Black brush	Coleogyne ramosissima
Buckwheat	Eriogonum spp.
Bush mint	Poliomintha incana
Winter fat	Erotia lanata
Rabbit bush	Chrysothamnus spp.
Iodine bush	Allenrolfea spp.
Yellow bush	Chrysothamnus greenii
Greasewood	Sarcobatus vermiculatus
Mormon tea	Ephedra spp.

WEEDS

Russian thistle	Salsola pestifer
Loco	Astragalus spp.
Sunflower	Helianthus spp.
Indian wheat	Plantage spp.
Cocklebur	Xanthium commune
Croton	Croton spp.
Larkspur	Delphinium spp.
Alfilaria	Erodium cicutarium
Careless weed	Amaranthus palmerii
Broadleaf Milkweed	Asclepias spp.

WOODLAND SPECIES

Juniper	Juniperus monosperma
	" scopulorum
Pinon	Pinus edulus
Cottonwood	Populus macdougalii
Single leaf ash	Fraxinus spp.

Woodland species in the area include principally pinon and juniper. Woodland area comprises approximately 89,300 acres. This is a very important feature of the Unit when such a small acreage of woodland furnishes the only source of woodland products over such a large area.

d. Condition of Vegetation:

Vegetation over the larger portion of the Unit is in a very bad condition. This is especially true around population concentrations and permanent water, such as Tuba City, Moenave and Cameron. In these areas, usage has been so severe as to cause a great deal of depletion of the vegetative resources of the area and at present, the existing plant cover is greatly reduced in vitality. The condition of vegetation closely follows the areas as outlined on the utilization map. It will be noted from this map that a rather large area in the vicinity of Marble Canyon west of Bodaway House is under-utilized. The same is true on Coal Mine Mesa. In these areas, the condition of vegetation is good to excellent with a rather dense vegetative cover and the

plants exhibiting increased vitality with ample volume growth. Conditions within woodland stands follow rather closely the condition of other vegetation, being severely over-utilized in areas adjacent to population concentrations or in out-lying stands.

e. Poisonous Plants:

Poisonous plants are rather widely spread over the entire area, but as a rule are not in abundance and for the most part, with the exception of loco, cause little damage. Poisonous plants include loco, Rayless goldenrod, greasewood, broad-leaf milkweed, lupine, larkspur, and cocklebur. Loco (Astragalus spp.) is widely spread over the entire Unit and occurs in hazardous quantities in the Bodaway House-Cedar Ridge area. Various species of this plant occur but principal damage comes once in about five to seven years when, because of favorable climatic conditions, a large number of these plants occur. This past year was an ideal year for the production of loco and severe losses were sustained, especially in horses.

Rayless goldenrod (Isocoma wrightii) and broad-leaf milkweed (Ascleopas spp.) occur along the drainages of the Chin Lee and Shinarump formations. Although widely spread and generally abundant, losses from these plants were not reported. Greasewood (Sarcobatus vermiculatus) occurs principally around Tuba City and although death losses have been reported, they may be attributed principally to improper herding methods. Lupine (lupinus spp.)

larkspur (Delphinium spp.) and cocklebur (Xanthium commune) are restricted to small areas and are not abundant. No losses from these plants were reported. As a whole, Unit No. 3 is relatively free from death losses due to poisonous plants. Eradication is deemed uneconomical.

4. Social Developments:

a. Population:

The population of Unit No. 3 is rather evenly distributed over the entire area with the exception of a concentration at Tuba City, due primarily to the presence of the boarding school, hospital, trading posts, permanent livestock water, and agricultural land. Lesser concentrations, all of them of a seasonal nature, are to be found on Gray Mountain, on Coal Mine Mesa, and at the Gap, and the Bodaway House. The population is made up primarily of Navajo Indians with a small group of Hopi living at Moencopi village. The 282 consumption groups (40 Hopi and 242 Navajo) account for the population of 1959 people (230 Hopi and 1729 Navajo).

b. Accessibility:

(1) Primary Roads:

Primary roads in the Unit include U. S. Highway No. 89, entering the Unit south of Cameron and continuing north by way of Gap and Cedar Ridge and leaving the Unit at Lowery's lodge at the Navajo Bridge. State road 64, between Cameron and

the Grand Canyon, crosses the southwest portion of the Unit. Both of these roads are passable at all seasons of the year.

(2) Secondary Roads:

Secondary roads include the Tuba City-Kayenta Road, the Tuba City-Hotevilla Road, Cameron-Needmore Road. Numerous wagon trails radiate from the primary and secondary roads, making the entire area accessible to car.

(3) Telephones:

Telephone connections in the Unit are adequate at the present time. The Flagstaff-Tuba City line, the Tuba City-Hotevilla line, the Tuba City-Kayenta line, and the Tuba City-Gap line furnish the telephone connections for the Unit. A telephone exchange for the western Navajo jurisdiction is located at Tuba City.

c. Trading Posts:

There are six trading posts located within the area; namely, the Tuba City Trading Post, Curley's Post, Gap, Cameron, Cedar Ridge and Lowery's Lodge. The trade of the Unit, however, is affected by various trading posts outside of the Unit, principally at Kaibito, Red Lake, Hotevilla and Sand Springs.

d. Schools and Hospitals:

Schools in the Unit include an Indian Service boarding school at Tuba City, a day school at Moenave and a county school

at Tuba City. Medical facilities include the Indian Service Hospital at Tuba City.

C. THE EFFECT OF ENVIRONMENT ON HUMAN ACTIVITY:

There are two entirely different types of people involved in the management of Unit No. 3; namely, the Navajo and the Hopi. Whereas the Navajo are principally nomadic people depending upon livestock as their primary source of income, the small group of Hopi at Moencopi village are primarily farmers, depending on livestock as a secondary source of income. The 230 Hopi in the Unit are congregated in one locality at the Moencopi Village. Cultural methods in farmland operated by Hopi are much better and larger yields are obtained from their land than that of the Navajo. Numerous Hopi are employed as truck drivers, whereas only a few Navajo utilize this occupation as a source of income.

The livestock industry within Unit No. 3 has definitely shown results of a contact between Indians and the immediately surrounding white men. Numerous sires of improved quality have been imported into the area and many of the bands exhibit a great deal of improvement because of improved sires and methods of handling the livestock.

The people of the area have acquired many of the more civilized methods of living. Numerous trucks and pick-ups are owned within the Unit. Educational facilities have been such that a large percentage of the population have received at least a grammar school education. Medical facilities have been available

and the inhabitants have come to depend upon hospitalization instead of the traditional native medicine man.

D. HUMAN ACTIVITY AND RESOURCES OF THE AREA:

The Value of the Land as a Resource

The principal value of the land within this area is for the production of livestock. Of the 1,760,000 acres within the Unit, 16% or 1/6, is waste or barren. Woodland comprises 5% and cultivated 1/8 of 1%. Only 2,177 acres are cultivated throughout the area, or approximately one acre per capita. The woodland in the area also serves as a valuable grazing resource, together as a source of wood and wood products. In other words, the area used as grazing land comprises approximately 84% of the entire area. Very little potential agricultural land is present within the Unit and adverse ecological conditions persist, making afforestation possibilities very slight throughout the area. Livestock production, then, from a land use standpoint, will continue to be the most important industry of the area.

1. Livestock and Range:

a. Present Resources:

(1) Area and Carrying Capacity:

The area comprising the range land within the Unit has a carrying capacity of 47,988 sheep units yearlong. For such a large area, this is a comparatively low carrying capacity figure and can be explained by the presence of large areas classified

as range land but with such a sparse vegetative cover that practically no carrying capacity is present. Over a large area, a forage acre factor of .01 or .02 with a percentage cut of 25 to 100% for slope, soil, or erosion conditions is not uncommon.

(2) Range Soils:

The range soils have been classified into five groups. Group "A" consists of soil having excellent range qualities, including moderate slope, moderate erosion, high water-holding capacity, and an alkali content which does not impair the growth of desirable native vegetation. In this classification falls a large area to the west of Bodaway House, to the south of Cameron, and on Coal Mine Mesa. These soils will respond rapidly to a proper range program.

The "B" class range soils have desirable range qualities but because of some factor, they have not been classed in the above group. Erosion not severe, water penetration and water-holding capacity is less, and alkali may or may not, be present. These soils will respond readily to a range control program but recovery will be slower because erosion conditions have advanced farther than in the above class. Grade "B" soils are present on Coal Mine Mesa, in the Lower Basin, and near the Bodaway House.

Grade "C" soils have less productive value than the above class. Erosion is severe to moderate and permeability is relatively low. A large area north of Tuba City, and small areas throughout

the entire Unit fall into this class. Range recovery on these soils will be relatively slow.

Class "D" soils are those, once productive but now because of erosion conditions, essentially destroyed. These comprise areas, especially alluvial valley fills or isolated areas, where wind erosion or range depletion have caused severe erosive effects. Range recovery on these soils will be extremely slow and only under very careful management will they return to their original productive state.

There has been a further division of soils, Class "E". This group includes areas where, at the present time, geologic erosion is taking place. Practically no vegetative cover is present and a very shallow, spotted soil cover is present. In many cases, only the parent soil material is present. For the most part, range soils of the area fall into either Class "A", Class "B" or Class "E".

(3) Season of Use and Class of Stock:

The vegetation and climate of the area make the entire Unit available for use as yearlong range. However, water conditions in the western portions of the Unit are a limiting factor in this regard. The water development in relation to seasonal use and a proper range program is discussed under Water Developments.

Either class of stock, sheep or cattle, may be used to stock the area. Vegetation is such that either class could utilize the forage. However, a relatively small area on Ward Terrace and immediately around Cameron is comprised primarily of coarse grasses and is better suited for use by cattle than by sheep.

(4) Livestock Water:

The problem of livestock water on the Unit is a serious one. For reasons of discussion and classification, the area may be divided into two divisions; namely, the area west of Highway 89 and the area east of Highway 89. In the latter, permanent water is available and is rather plentiful over the entire area. A few isolated areas on Coal Mine Area are the exception. Recent drilled wells in this locality furnish the principal water supplies. However, additional water may be found to be necessary. Permanent water supplies west of Echo Cliffs in the vicinity of Gap Trading Post, Tuba Butte and Tuba City have resulted in a heavy concentration of livestock during the summer months with consequent range depletion. Enough livestock range in the area, on a yearlong basis, to more than meet the carrying capacity for the area involved; and in addition, large numbers of livestock pour into the area during the dry season because of available water.

The area lying west of Highway 89 is singular in that no permanent water exists at the present time. The area is cut

by deep canyons on the south and on the west, allowing water that would otherwise be available in the form of drilled wells to be drained out of the area. Earth reservoirs and a few shallow wells furnish the only livestock water available. In large areas, runoff is very slight and surface water is impractical. In other areas, only limestone formations form available damsite locations. In these locations, any large head of water will cause the limestone to dissolve and water to be lost due to sink holes and crevices. The problem of developing water becomes an important factor in a range control program. Several sites have been recommended for development, but from a geological standpoint are rather risky. If permanent water is not available in the area, the livestock plan for the area must be modified in order to use the area when temporary water is available, depending upon the permanent water around Tuba City during the dry season. If this plan is adopted, a large amount of trailing and trampling to vegetation will result and every effort should be made to avoid any further trailing of herds.

The 172 water developments located during the survey of the area may be classified as follows:

12	Permanent Drilled Wells
24	Shallow Wells, Permanent
18	Developed Springs, Permanent
24	Undeveloped Springs, Permanent
8	Permanent Reservoirs
77	Temporary Reservoirs
9	Temporary Shallow Wells

(5) Wildlife:

Speaking in generalities, Land Management Unit No. 3 has a relatively sparse present population of wildlife. Rodent life is more abundant than other forms of wildlife but only in local areas is the population relatively abundant. Concentration and damage by these individuals is discussed under various topics depending upon factors influenced by them; specifically, range, farm, and woodland resources.

Game animals are relatively scarce over the entire area, primarily because of present unfavorable habitat. The area is relatively scarce in water supplies and natural food for game animals, together with incomplete legal protection at the present time. All factors summed up make for an unsuitable game habitat.

Migratory waterfowl are present in the Unit at all seasons of the year, especially at the Hopi Reservoir. During migratory periods the population of migratory waterfowl is greatly increased but because of present lack of suitable resting places, the area is not at present important from a migratory waterfowl standpoint.

Upland game birds are present in small numbers. Two coveys of Gambel quail are present in the vicinity of Moenave Demonstration Area but habitat conditions are such that a large increase over the present numbers is not to be expected. Mourning Doves range in moderate numbers over the entire Unit during the summer months.

Predators and furbearers at present are not abundant except Coyotes. Rather large numbers of these individuals are present. Present extent of trapping in the area by Indians is effectively keeping over-abundance of these animals in check.

Predatory birds occur in moderate numbers and are aiding materially in rodent control, especially the smaller rodents such as mice, rats, etc.

The following table gives a list of species of wildlife in the area with pertinent data regarding abundance and suitability of habitat:

Table II Wildlife in L. M. U. No. 3

	Abundance	Range	Habitat
BIG GAME:			
Mule deer	Few	Gray Mountain	Suitable
Bear	Rare	" "	"
Antelope	Moderate	South edge of Unit	Good if protected
Mountain Sheep	Doubtful	Lower Basin	Not suitable
SMALL GAME:			
Cottontail Rabbits	Plentiful	Entire Unit, esp. Tuba City and Grey Mt.	Good to Excellant
Rock Squirrels	Rare	Grey Mountain	Too dry
Abert Squirrels	Doubtful	Grey Mountain	Not suitable
FISH:			
Croppies, Bass	Moderate	Hopi Reservoir	

Table II (Continued)

	Abundance	Range	Habitat
MIGRATORY WATERFOWL:			
Ducks	Few except during migration.	Hopi Reservoir and some stock stock tanks.	Good
UPLAND GAME BIRDS:			
Turkey	Doubtful	Grey Mountain	Not suitable at present.
Dusky Grouse	None		Not suitable.
Gambel Quail	Few	Moenave	Good for present numbers.
Scaled Quail	None		Good for few flocks.
Mourning Dove	Abundant	Entire unit.	Good.
FURBEARERS:			
Coyote	Abundant	Entire unit	Good
Bobcat	Few	Echo Cliffs, Coal Mine Can.	Good.
Badger	Few	North of Tuba City, west of Gap T.P.	Good
Fox	Few	Grey Mountain	Fair
Skunks	Uncommon	Rocky Areas	Fair
RODENTS:			DAMAGE:
Prairie Dogs	Abundant in 400,000 Acres.	West of Gap, esp. but found throughout Unit.	Severe in approximately 200,000 Acres.
Kangaroo Rats	Abundant in 600,000 A.	Entire Unit.	Esp. farmland.
Ground Squirrels	Common	Entire Unit.	Little damage.
Miscellaneous Mice	Common	Entire Unit.	Esp. to reproduction in woodland stands and in farming areas.

A list of the more common winter birds of the area includes: Desert Horned Lark, Nevada Red-wing, House Finch, Gambel sparrow, Northern Sage Sparrow, Brewer Blackbird, Mountain Bluebird, Green-backed Foldfinch, Killdeer, Western Meadowlark, and the Lead-colored Bush-tit.

Ten most common breeding birds on Land Management Unit No. 3 include: Desert Horned Lark, Desert Sparrow, Mourning Dove, American Raven, White-rumped Shrike, Common House Finch, Common Rock Wren, Say-Phoebe, Cassin Kingbird, Nuttall Poor-will.

Many other sight records of other individuals were made during the survey but only small numbers of individuals were apparent. As a whole, bird life in general is uncommon over the entire Unit. During the survey 14,250 individuals belonging to 66 species were observed.

Various water supplies on the Unit are valuable from a wildlife habitat standpoint. Many of the streams, reservoirs and springs may be improved for a wildlife habitat by proper planting. A classification of each supply has been made, placing emphasis on food available, permanence of water, protection, and other factors. For further information see "Biology Report, Land Management Unit No. 3".

b. Utilization of Range Resources:

(1) Present Number and Class of Stock:

Present class of stock in the area is predominantly sheep. A change is not recommended other than reduction

of excess horses.

The following list graphically represents the livestock population compiled from 1937 Dipping Vat Records and Cattle and Horse Round-up: (539 eligible permittees)

Table III

Class	No. of Head	Sheep Units	% of Total
Ewes	25,197	25,197	
Wethers	3,523	3,523	
Rams	780	780	
Total Grown Sheep	29,500	29,500	56.77%
Nannies	2,687	2,687	
Billies	240	240	
Wethers	217	217	
Total Grown Goats	3,144	3,144	6.05%
Cows	1,196	4,784	
Bulls	76	304	
Steers	80	320	
Total Grown Cattle	1,352	5,408	10.41%
Mares	914	4,570	
Stallions	74	370	
Geldings	1,321	6,605	
Mules	285	1,425	
Burros	188	940	
Total Grown Horses	2,782	13,910	26.77%
	Total	51,962	100. %

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Table III (Continued)

Class	No. of Head	% Crop Based on Total Grown Stock per Class
Lambs	16,801	57% lamb crop
Kids	2,449	78% kid crop
Calves	671	50% calf crop
Colts	539	19% colt crop

Present Stock (sheep units yearlng)	51,962
Carrying Capacity " " "	47,988
Sheep units overstocked	3,974
Percent overstocked	8.28%
Percent adjustment necessary	7.65%

(2) Relation of Stocking to Carrying Capacity:

From observations of utilization in the field at the time of the survey, it was very evident that a large portion of the area is excessively overstocked. On the other hand, a large area of high carrying capacity range was found to be understocked principally because of a lack of water. When these are compared for the area as a whole, it may be found that the actual overstocking is not so great as indicated by the appearance of a large area, especially around Tuba City. From 1937 dipping records the area is only 8.28% over stocked.

(3) Distribution and Livestock Movements:

The livestock at present show very poor distribution over the entire Unit. Concentrations around permanent water supplies are present at all times and seasonal concentration on Gray Mountain, Coal Mine Mesa, Cedar Ridge and the Gap are evident. At present, there are long shifts of livestock between winter and summer range from the area immediately around Tuba City to all other portions of the Unit. Such movements of stock result in heavy damage to the vegetation from trampling and trailing.

(4) Seasonal Use:

In the Central portion yearlong usage persists with a heavy concentration during dry seasons. The western and southern portions of the area are used primarily as winter range, depending upon the availability of temporary water. Coal Mine Mesa is used as winter range but with the recent development of water has come to be used more as yearlong range.

(5) Animal Husbandry Practices:

(a) Selection:

Selection in the livestock of Unit No. 3 is above average for the Reservation. This is especially noticeable in the cattle for the area. Many herds of rather uniform individuals with desirable market type and quality were seen during the survey. Large bands of sheep within the area show the improvement of good sires and are rather uniform throughout. Selection in the smaller herds is not so advanced as it is in the larger

herds. The smaller herds are not predominantly long-wooled sheep of undesirable type. Many off-type and off-color individuals occur.

(b) Bucks and Bulls:

At present, there is not a sufficient number of bucks and bulls for the area and many of the bucks and bulls present are of poor quality and are unsound. The herds of cattle show the direct influence of bulls owned by white owners immediately outside the Unit, which the Indians have used. In determining the number of bucks and bulls needed for the area, a ratio of three bucks per hundred ewes, and six bulls per hundred cows, is recommended.

(c) Breeding and Lambing:

Breeding and lambing seasons occur yearlong throughout this Unit. Although the apron is used, it is far from satisfactory and lambs come at all seasons of the year. The principal season for lambing occurs in February, usually during stormy weather. During the survey, many herds were lambing when twelve to eighteen inches of snow was on the ground. Under such conditions, it is no wonder that the death rate of lambs and mother ewes is very high. Further damage to the herd is done by the slipping of wool, due to lambing in inclement weather.

(d) Docking and Castrating:

For the most part, it is the common practice to dock lambs too long, giving a shaggy appearance to the lambs at time of sale. For the most part, lambs are castrated at too early an age, giving rise to many staggy individuals.

(e) Shearing:

Shearing is at present carried on at too early a date, the season, beginning at the present time on or about April 1 and continuing for approximately a month with most of the sheep being shorn about April 15. This not only decreases the amount of wool clip but also relieves sheep of protection in case of late spring storms. It was also noticed that rams were among the first sheep to be shorn. Hand shearing is the universal practice throughout the district.

(f) Herding:

Herding practices at present are not conducive to proper range management or to proper animal husbandry practices. Extensive trailing and trampling to and from water and to and from winter and summer range is a prevalent practice in the area. Herds are driven instead of being herded from the front to make them scatter out and more effectively utilize available forage. Only in a small number of instances were proper herding methods demonstrated. Bedding in the same corral over extended periodf of time has caused severe depletion of adjacent range. This factor

is also important in the transmission of disease and pests, especially grub-in-the-head and lice.

(g) Salting:

Salting is done by browsing the sheep on salt species. In certain areas there is available a relatively large quantity of salt bush species. However, in a relatively large portion of the area, only a small percentage of the vegetative cover is made up of any species that afford salt. It is the exception rather than the rule that livestock salt is furnished to the herds. In many instances, salt bush species have been completely killed out over large areas by excessive use. The salt requirement for the Unit would be from 100 to 125 tons annually. At present, there are only a few thousand pounds of salt within the Unit. Alkali water has aided in part to reduce the salt requirements for animals, but at present there is a decided deficiency in salt provided for livestock. It will be necessary for the Indians to furnish a large quantity of salt in order to establish proper range management practices.

(h) Supplemental Feeding:

Inasmuch as approximately one eighth of one percent of the land in the area is cultivated, with only a very small amount of potential agricultural land, the area available for the production of livestock feed is exceedingly small for the entire Unit. At present, supplemental feeding consists of

feeding corn stover or other feed crops produced within the Unit and the importation and feeding of a small amount of hay and grain to horses. This practice affects only a small portion of the livestock population in the Unit, and under the conditions of the Unit it must be expected that the practice of supplemental feeding can amount to very little more than is at present practiced.

(i) Dipping:

Dipping of sheep and goats is carried on annually at present. There are dipping vats located at Tuba City, Cameron, and the Gap. Vats outside the Unit but having an effect upon the area are located at Red Lake (Tonalea), and Sand Springs. There is an abandoned cattle dipping vat at Poverty tank and an abandoned sheep dipping vat at Needmore tank.

(6) Livestock Pests and Diseases:

Grub-in-the-head of sheep is the most serious animal disease reported for the Unit. A factor especially important in the epidemiology of this disease is the continued use of the same bedgrounds over extended periods of time. Lice, scabies and ticks are at present held in check by dipping. Scabies has not been reported for the area for a period of nearly three years. Screw worms are not reported for the area. Ox-warble is reported but is uncommon for the Unit.

(7) Range Rodents: (See Biology Map.)

Principal rodents in the Unit include prairie dogs, kangaroo rats, pocket gophers, ground squirrels, and miscellaneous mice. Prairie dog infestation is serious in 65,500 acres of range land and a factor worthy of consideration in an area exceeding 220,000 additional acres.

Type G-31 lying west of Cedar Ridge Trading Post shows the heaviest concentration of prairie dogs. Over a large area in the vicinity of Tuba City and Red Mesa, Types G-1 and G-2, a large population of prairie dogs was present, but treatment in 1935 has proven quite successful in reducing population and damage. Numbers of prairie dogs in localized area within these types are such that damage is resulting and eventually the area will need to be retreated.

Kangaroo rats are relatively abundant over large areas and are causing some damage to range vegetation but cost of control is considered to be much larger than the damage caused by the rodents.

Ants as an insect on range land are uncommon and not in sufficient abundance to cause severe damage. Grey Mountain is the most seriously infested area.

Other range rodents are causing but little damage and cost of control exceeds the damage done by the rodents.

The acreage by types of the various concentrations and the relation to carrying capacity for the area affected by each type

have been compiled and are available in the Biology Branch Report of Land Management Unit No. 3, by Gale Monson.

(8) Range Predators:

Predatory animals in the Unit include coyotes, bobcats, Navajo dogs, badgers, foxes and skunks. Most numerous and responsible for most damage is the coyote. Trapping of this animal is done to some extent by the Indians. At present their numbers are not severe enough to warrant a control program. Although there were no reports that Navajo dogs are predators, it is felt that some losses attributed to coyotes were depredations of predatory Navajo dogs.

Bobcats are uncommon. Skunks, badgers and predatory birds (hawks, owls, etc.) are doing much to keep the rodent population from increasing and are not causing livestock losses.

An occasional mountain lion, bear, or lobo wolf may stray into the Unit from the San Francisco Mountains or Grand Canyon areas, but there have been no records of such happening for a number of years and serious depredation has not been reported.

(9) Poisonous Plants:

As has been previously pointed out in the report, the western portion of the Unit is the only hazardous poisonous plant area, the most important species being loco. The problem in this locality is a difficult one for several reasons: first, there is an abundance of loco present; second, a large variety

of species exists, some annual and some perennial; third, horses, primarily, are affected. It has been found that bad loco years occur approximately one out of every four to seven years, the intervening years not presenting a very serious problem. Sheep, for the most part, can be grazed in the area even in the worst years without serious death loss from loco. Cattle and horses, however, range the area uncontrolled by herding methods, and severe damage may be sustained. At present, the area is used during the spring when most severe losses occur.

(10) Other General Conditions:

The relative carrying capacity for the area as a whole is low, primarily because of a large amount of barren and waste land being present. Together with this is the fact that large areas of black brush, with no under-story of grass, are present. In most of these areas there is a forage acre factor of .01 or .02, with cut of 20 to 100% for soils, slope and erosion. This, as a whole, brings the relative carrying capacity for the area entirely down below average.

General range conditions throughout the Unit closely follow the areas as outlined on the utilization map. Areas which have received ample rainfall and have at present good plant vigor with ample volume growth, closely follow areas as outlined on the utilization map.

A problem which presents itself in this Unit concerns a

division of range between Hopi and Navajo livestock. At present there is a great deal of conflict, between Hopi and Navajo livestock owners as to range usage, and for administrative purposes it is deemed advisable to separate an area for Hopi usage. According to all available information, the present Hopi livestock is equal to slightly more than 1000 sheep units. Approximately 2500 forage acres would be needed in order to carry the livestock on a yearlong basis. At present, Hopi usage is primarily to the south of Moencopi village on Coal Mine Mesa and Ward Terrace. The Kloy-e-chee Rim furnishes a natural barrier and there is approximately eight miles of fence already constructed along the Tuba City buck pasture which would serve in excluding a portion of the range on Coal Mine Mesa for Hopi usage. An additional eighteen miles of fence would enclose an area on Coal Mine Mesa lying south of the Moencopi Wash, which could be used as Hopi range. Further surveys and compilations will be necessary before definite information in this regard will be available. A diagram showing the location and enclosed fence accompanies this report.

c. Marketing:

(1) Home Consumption and Sale:

Gross livestock income for the Unit was $100,313.98 divided as follows: home consumption, $29,626.00; commercial income from sale of livestock and livestock products to the traders,

$70,687.98. (For further breakdown of livestock products see "Income"). According to available livestock statistics there was a return of $1.73 per sheep unit run. It may be possible that certain large owners sold direct to buyers at the railroad or held over their stock without selling. It is difficult to obtain accurate information in this regard.

(2) Barter:

Use of livestock and livestock products in sale, trade, and barter is an influencing factor but the extent to which these are used in this regard is not definite.

A table showing the relative importance of the various livestock products as a source of commercial and non-commercial income follows:

Table IV — Livestock Income

Item	Commercial	Non-Commercial
Sheep, goats & lambs	$12,512.95 - 18%	$25,926.00 - 88%
Cattle	6,866.89 - 10%	3,700.00 - 12%
Wool and mohair	35,487.46 - 50%	
Pelts	800.65 - 1%	
Meats	15,020.03 - 21%	
	$70,687.98	$29,626.00

Total livestock income - -$100,315.98

2. Farming and Farm Resources:

a. Present Resources:

(1) Present Farmland:

(a) Acreage and Type:

Two extremes of farming methods are exhibited in Unit No. 3. The first consists of the typical Navajo method of farming with poor tillage practices, uneconomic use of water, and the consequent low production per acre. The second method, typified by Hopi agriculture, consists of relatively intensive farming with very much improved tillage practices, a more economic use of water, and a relatively high crop production per acre. At present, there are 2177 acres of agricultural land located within the Unit, an area representing only one eighth of one percent of the total area for the Unit. This may be further sub-divided into irrigated, flood irrigated, and dry farming land, and still further sub-divided according to land class, "A", "B" and "C". A table showing these relationships follows:

Table V — Present Agricultural Land

	Class A	Class B	Class C	Class G	Total
Irrigated	1,146	13	4	32	1,195
Flood Irrigated	451	220	6	11	688
Dry Farm	271	18	5		294
Total - -	1,868	251	15	43	2,177

(b) Location and Distribution:

There are five agricultural areas within the Unit; namely, Tuba City and vicinity, Moenave Demonstration Area, Coal Mine Mesa, Willow Springs and vicinity, and Cedar Ridge. The farmland at Tuba City lies in the alluvial valley floor and is comprised practically entirely of irrigated land with the source of water being the Moencopi Wash. Water for agriculture comes primarily from springs and is present at all times. However, only one storage, the Hopi reservoir, is available for storing water during the winter months for use during the growing season. The lower Moencopi area has had a diversion dam constructed, but at present there is no land which is farmed in the area.

The Moenave Demonstration represents an agricultural area which has been developed by the development of springs and the providing of small storage reservoirs. Here, a more stable flow of water for agricultural use is to be found. Intensive farming, especially of crops such as peaches, apples, grapes, vegetables, etc., are to be found. A large expenditure on the part of the Soil Conservation Service has been made to develop this land.

Coal Mine Mesa affords an agricultural resource in flood irrigated farms. A sandy soil with high water penetration and medium water-holding capacity is present. Practically all the farms are located on gully fans and are rather highly productive under proper management. Nearly all the better flood irrigated farms are to be found in this area.

At Willow Springs several scattered farms are located. For the most part, water from springs serves as a source of irrigation. The terrain is too steep and the soil too easily eroded to provide for flood irrigated farms in this area. Generally, intensive farming methods persist in this locality.

The Cedar Ridge area lies in the alluvial valley to the north of Cedar Ridge Trading Post and comprises only a few scattered farms. Water for agricultural purposes in this area is dependent upon local rainfall. Soils in the area are relatively low in productive value, and the area as a whole is only average in crop production. The typical Navajo method of farming prevails.

(c) Agricultural Soils:

Agricultural soils within Unit No. 3 are limited to alluvial deposits along Moencopi Wash and the Little Colorado River and are grouped in the following series:

Dinnehotso
Hunt
Concho
Dinnebito
Gila
Cameron
Tolani

Types in the Dinnehotso, Hunt and Tolani series are derived primarily from the Chin Lee and Moencopi shales and as a rule are rather high in alkali content. The topography is level or gently sloping with the surface broken by hummocks and sand drifts varying from twelve to thirty-six inches in depth. The latter materially increase subjugation costs. These soils occur

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along the Moencopi and secondary drainages from south and west to Cameron. Types in the Dinnehotso series have deep, friable sub-soils which give these soils an advantage over the other two series from an agricultural standpoint. The sandy loam and clay loam types are usually Grade "A" agricultural land, provided the alkali content does not exceed 2/10 of 1%.

Types in the Hunt series differ from those in the Dinnehotso by the frequent occurrence of a heavy, impervious strata which is the result of poor sub-drainage. This is extremely important in the concentration of alkali. Hunt sandy loam is rated as "B" or "C" agricultural land.

Types in the Tolani series consist of recent over-wash, usually deposited over one of the preceding types. The salt content is usually lower with a deep friable sub-soil, but as a rule the soil is subject to severe sheet and wind erosion and reduces its value to a "C" grade agricultural.

Soils in the Gila series occur principally along the Little Colorado River southeast of Cameron. They are favorably located from the standpoint of irrigation, and the texture, both on the surface and sub-soil, is predominantly light. This soil is approved for agricultural development provided the alkali content or high ground water table does not prevent its use. Since there is a decided lack of agricultural land within the Unit, it is advisable that consideration be given to the possibility of development on types of this soil series.

The Concho series are distributed along the Moencopi drainage south of Tonalea. The topography is level to hummocky and the sub-soil is heavy and often impervious. The surface soil is often highly dispersed by the physical action of certain salts. The sandy loams and clay loam, depending upon the alkali content in the root zone and the clay content in the sub-soil, have about the same agricultural qualities as the series described above and are classified as Group "C" or "D" non-agricultural land because of the danger of alkali concentrations under irrigation practices.

Types in the Dinnebito and Cameron series are located in the southeastern portion of the Unit and are good to excellent range soils but their development for agriculture is dependent primarily upon availability of water.

Alkali in agricultural soils is a very important factor to be considered in the development and present cultural practices in the Unit. All of the agricultural land tends to have alkali present and without adequate sub-drainage or through improper cultural methods, alkali concentrations may become so great as to render the land unfit for crop production. It will be necessary and justifiable to have detailed soil analyses on all new agricultural developments. A further problem which is encountered and needs further detailed surveys, is the problem of alkali spreading from present concentrations onto adjacent agricultural land.

(d) Yields:

Because of the presence of Hopi agriculture and the Government farm at Tuba City, a more versatile list of agricultural products is produced within this Unit than is to be found under similar conditions on the Reservation. No actual crop production records were made during the survey, as the survey was completed during the winter months, and crop yields have been estimated by comparing farmland in this area with that of adjacent units. A table showing the crops produced, present yields and expected yields under proper farm management follows:

Table VI — Acreage and Yields of Present Crops with Expected Yields

Crop	Present Acreage *	% of Total	Pres. Yields (per Acre)	Exp. Yields (per Acre)
Corn	1,216	55.86	20 bu.	25 bu.
Idle	423	19.43		
Sudan Grass	225	10.34	3 tons	4 tons
Vegetables	108	4.96		
Orchard	72	3.31		
Alfalfa	51	2.34	2 tons	3 tons
Squash	19	.87	4000 lbs.	5000 lbs.
Melons	46	2.11	4000 "	5000 "
Beans	17	.78	300 "	400 "
Total	2,177*	100 %		

*This includes 365 acres in the Government Farm at Tuba City and Pasture Canyon.

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From a study of the preceding table, it will be noted that corn is the predominant agricultural product and that present yields are above average for the Reservation. Sudan grass, vegetables, orchards and alfalfa come next in importance. By the efficient use of available water, and by improved agricultural practices for the conservation of soil and moisture, yields can be expected to be increased from 25 to 50%.

(2) Potential Farmland:

(a) Acreage, Type and Location:

Potential agricultural resources within the area are very limited. For the most part, the potential land consists primarily of additional developments at present agricultural sites. The development at the lower Moencopi damsite is one of the entirely new agricultural developments in the Unit. The following table shows the distribution and class of potential agricultural land in the Unit.

Table VII Potential Agricultural Land

	Class A	Class B	Class C	Class G	Total
Irrigated	96	0	0	5	101
Flood Irrigated	77	0	0	20	97
Dry Farm	6	0	0		6
Total - -	179	0	0	25	204

(b) Expected Yields:

Expected yields under improved methods of farming are classified the same for present and potential land (See Table VI).

(3) Agricultural Pests:

(a) Insects and Diseases:

Principal insects affecting crops in Unit No. 3 are cutworms, grasshoppers, and codling moths. Cutworms cause most severe losses in nearly all cultivated crops and in many cases depredation is so severe as to necessitate replanting of the fields in order to obtain substantial yields. This insect damage shows its effect on a large majority of the cultivated fields in the Unit. Grasshoppers rarely do serious damage to crops as a whole in the area. However, on small farms bordered by range land they often become so numerous as to be classed as a serious factor. Fall plowing and poisonous bran would effect control.

Codling moths are a serious insect on apple trees. Spraying in Moenave and Tuba City area is effectively controlling damage by this insect. At present spraying is done through cooperation with government agencies, U. S. I. S. and U. S. S. C. S. Present equipment is not sufficient to control codling moth on all farms.

Other insects are present, and in combination cause damage

to crops. These include army worms, potato beetle wireworms, borers, etc.

Plant diseases caused by fungi or bacterial growth are a negligible factor in the Unit. A small amount of smut on corn is present but no appreciable damage is done.

(b) Rodents:

Kangaroo rats, pocket gophers, and, to a much lesser degree, mice constitute the principal rodent problem on farmland. Practically all farmland is affected by rodents, in many cases the depredation being so severe as to cause complete crop losses or a very small crop production. In some cases replanting of fields is necessitated by invasion of rodents. Prairie dogs do not furnish a severe rodent problem in cultivated areas at present. A light concentration with corresponding light damage persists at the present time.

Control of rodents around farmland is recommended, bearing in mind the extent of damage and concentration of rodent population.

(c) Weeds:

Weeds constitute an important crop pest in a portion of the farmland. At two locations within the Upper Moencopi farms white top weeds have been reported and need control before they advance on farmland. Seeding and rooting habits of this plant make eradication difficult if invasion has become advanced.

Cocklebur and a few other weeds of minor importance were found to persist in many fields. Proper cultural methods will do much to eradicate these weeds.

Weed control, especially proper cultural practices with specific attention to white top, will be effective in reducing damage to crops by weeds.

b. Present Utilization of Farm Resources:

(1) Present Farming Methods:

(a) Type of Farming:

The type of farming to be found in Unit No. 3 exhibits two extremes, as has been previously pointed out. As a whole, however, either intensive farming methods, or the other extreme of unconcentrated farming practices persists, with very few farms exhibiting a mean.

(b) Farm Machinery:

For the most part, the use of hand implements, especially the walking plough, is the prevalent practice throughout the Unit. Practically no farming machinery is present other than the plough. Cultivating is done by the use of an improvised, hand-made cultivator. The use of improved agricultural equipment is to be encouraged. Planting, at the present time, is not done at the proper season. In some localities the crops are planted too early and in others the season is well under way before the crops are planted.

(c) Use of Water:

Whereas the Hopi farmers are making rather efficient use of water, Navajos are allowing it to concentrate in certain areas causing alkali concentration, and in other ways do not practice methods which are conducive to proper farm management, and in many cases are causing severe damage to agricultural land through mismanagement of water.

(d) Harvesting and Storing:

Harvesting, for the most part, is done by hand. Until such time that crop production is increased and the cost of labor is increased, this practice will be satisfactory. Storing of agricultural products, however, is open for improvement. Whereas for the most part crops are stored in underground pits or in the hogan, allowing for losses from rodents and spoilage, much improvement can be made by the construction of rat-proof storages. Hopi methods of storing are much advanced over those of the Navajo.

(e) Control of Farm Pests:

At present, little attention is being paid to pests and their control. Fall plowing, especially deep listing at right angles to prevailing wind, would do much to rid the farmland of a number of insects which cause severe crop losses, and at the same time, would not result in severe removal of soil by wind erosion.

c. Marketing:

(1) Home Consumption and Sale:

Income from agriculture is principally non-commercial, home produced and consumed. Only approximately, one percent is sold to traders - $962.88. Total income from agriculture amounted to $98,664.78 in 1936. A return per acre of $74.41 based on land actually cultivated and disregarding idle, potential, and Government farmland was represented by the area. For importance of various crops see "Income".

(2) Barter:

Agricultural products are used in sale, trade and barter among the Indians themselves. The importance and extent of this practice is not definite.

A table showing the relative importance of the various crops as a source of commercial and non-commercial income for the area has been prepared.

Table VIII Agricultural Income

Item	Commercial	Non-commercial
Corn	96% - $923.48	$35,005.48
Melons & squash	1% - 10.40	8,936.84
Potatoes	2% - 20.00	
Peaches & other fruit	1% - 9.00	38,541.02
Alfalfa		601.20
Beans		93.48
Vegetables		14,523.88
Total - - -	$962.88	$97,701.90

The following table shows the basic resources of agricultural land on the Unit, including location and classification of land, crops, and recommended subjugation or change in cultural practices:

Table IX — Present and Potential Agricultural Land in Land Management Unit No. 3

Location Quad No.	Tract No.	Topography	Soil*	Erosion**	Yield	Present Crops	Suggested Crops	Recommendations	Cost of Treatment: Present Acreage	Present Cost per A	Present Total Cost	Potential Acreage	Potential Cost per A	Potential Total Cost
7	98	Dunes	S-LS	S.wind	12 bu	Corn	Grain sorghum, corn, sudan grass, beans.	Contour list. Strip crop.	25					
7	97	1.5%	S-LS	S.wind	18 bu	Corn	Grain sorghum, corn, beans.	Contour list. Strip crop.	22					
7	101	Dunes	S-LS	S.wind	15 bu.	Corn	Grain sorghums, corn, melons, beans.	" " "	15					
7	105	Dunes	S-LS	"	15 bu	Corn	" " "	" " "	50					
7	106	Dunes	S-LS	"	12 bu	Corn	" " "	" " "	25					
7	406	2%	F SL	"	5 bu	Corn	Corn, beans	" " "	2					
7	407	Irreg.	S-LS	"	6 bu	Corn	Melons, corn, beans	" " "	3					
19	1	1%	S	Sl	Good	Sudan grass, corn, alfalfa.	Same as present.	None	340					
19	1.1	1%	S	Mod	Good	Corn, beans, idle.	" " "	Repair borders	32	$ 6.00	$190.00			
19	1.2	1%	S	Mod	Good	Corn	Corn, beans, melons.	None	2					
19	1.3	1%	S	Mod	Ave	Sudan grass, beans, corn.	Corn, beans, melons.	Furrow Irrigate	35					
19	1.4	1%	SL-CL	Sl	Ave	Corn	Corn, beans, veg*** orch.	Enlarge storage. Repair borders.	4	$ 6.00	$ 24.00			
19	1.5	1%	S-CL	Sl		Idle	Corn, beans, melons.	None	3					
19	1.6	1-2%	SCL	Mod	Good	Veg, Corn, beans.	Corn, veg, orch.	Provide water storage.	15	?	?			
19	1.7	1%	SCL	Sl	Good	Corn, squash	Corn, beans, orch, squash.	Erosion control.	285	?	?			
19	1.8	1%	C-CL	Sl	Ave	Corn	Corn, beans.	None	2					

*Soil abbreviations:
S = sandy
SL = sandy loam
C = clay
LS = loamy sand
FSL = Fine sandy loam
CL = Cley loam

**S = Severe
Sl = Slight
Mod = Moderate

***Veg = vegetables
Orch = orchard

Table IX

Location Quad No.	Tract No.	Topography	Soil*	Erosion**	Yield	Present Crops	Suggested Crops	Recommendation	Cost of Treatment: Present Acreage	Present Cost per A.	Present Total Cost	Potential Acreage	Potential Cost per A.	Potential Total Cost
71	11	1%	S	Mod	Good	Melons,squash	Veg	None	1-1/2					
71	12	1-3%	S-SL	Mod	Good	Corn,veg,orch	Same as present	None	6					
71	12.1	1-2	S	Sl	Good	Orch,corn,veg	Same as present-	None	11					
71	12.2	1-10T	S	Sl	Good	Orch,veg,corn	" " "	None	9			1		
71	12.3	1%	S-CL	Sl	Ave	Corn	Corn,beans	None	1					
71	12.4	1-3%	S	Mod	Good	Corn,veg,orch.	Same as present.	Check gully	9					
71	12.5	1-4%T	S	Mod	Good	Orch,veg	Same as present.	Check gully.	8					
71	12.6	1-2%T	S	Mod	Good	Orch,veg,corn	" " "	Repair borders	45					
71	12.7	1%	S	Mod	Good	Corn,veg,orch.	" " "	Plant windbreak	25					
71	12.8	1%	S	Mod	Ave.	Corn,beans,orch	" " "	Border	28	$12.00	$336.00			
71	12.9	1-4%	S	S	Good	Orch,corn.	Corn,orch,veg.	Plant gully	4					
71	12.10	5-10%T	S	Sl	Good	veg.	Orch,veg.	None	1					
71	12.11	1-2%	SL-CL	Sl	Ave	Corn,idle	Corn,squash,beans.	Border	18	$10.00	$180.00			
71	12.12	1-4%	S-SL	Sl	Ave	Veg,corn,idle.	Corn,veg,orch.	Develop spring	3					
71	12.13	1-2%	SL-CL	Sl	Ave	Corn,orch,veg.	Corn,beans,orch.	Check head erosion.	35					
71	13	1-2%	S-SL	Mod	Ave	Corn,idle	Corn,beans,oats.	None	6					
71	14	1-2%	S	S	Good	Corn,idle.	Veg, orch.	Drain water	1			4		
71	15	1-4%	SL	S	Good	Corn,veg,orch.	Veg,orch.	Put in ditch system.	7			2		
71	16	1-2%	SL	S	Good	Veg,corn,idle	Veg.	Plant windbreak. Level.	10	$ 5.00	$ 50.00			
71	17	1-4%	S-L	Sl	Ave	Native.	Vegetables.	Drain and level				25	$10.00	$250.00
71	17.1	1-5%	S-L	S	Ave	Native	Grass clove	Drain				10		
71	19	1-3%	S	Sl	Good	Corn,veg,orch, idle.	Corn,veg,orh.	Plant to control erosion.	10					

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Table IX (Continued)

Location Quad No.	Tract No.	Topography	Soil*	Erosion**	Yield	Present Crops	Suggested Crops	Recommendations	Cost of Treatment: Present Acreage	Present Cost per A.	Present Total Cost	Potential Acreage	Potential Cost per A.	Potential Total Cost
19	12	4-5%T	SL	Mod	Good	Orch,corn,melons.	Orch,grapes,corn.	Divert flood water	4					
19	16	5%T	S	Mod	Good	Orch,melons,corn.	Corn,orch,veg.	Divert water and store.	6			5	$15.00	$ 75.00
19	17	4%T	S	S		Idle	Corn,orch,veg.	Abandon present land. Border potential.	4			10	18.00	180.00
19	18	6-7%T	CL- C	S	Ave	Corn,veg.	Veg,orch,corn.	None	2					
19	19	8%T	SCL	S	Ave	Corn,orch	Same	None	1/4					
19	20	5-6%	SL-CL	Mod		Idle	Orch,veg.	Use water more efficiently.	1					
19	21	5-6%	SL-CL	Mod	Ave.	Orch,alf, corn	Corn,orch,vg	Repair terraces	3	?	?			
70	1	1-2	S	Mod		Idle	Corn,squash,beans.	Spread water more evenly.	30	$ 5.00	$150.00			
70	2	1	S	Mod		Idle	Corn,squash,beans	" " "	16	5.00	80.00			
71	1	1-2%	S	Mod		Idle	Corn	Contour list	16					
71	2	1-3%	S	Mod	Ave.	Corn 35,Idle 90.	Corn, bans	Spread water.	125	?				
71	3	1%	S	Mod		Idle	Corn, bans,squash.	Contour list	8	?				
71	4	1-2%	S	Mod		10 idle,4 orch.	Corn,stash,melons.	Contour list	14					
71	5	1%	S	Mod		Idle	Corn,buns,melons.	Contour list	6					
71	6	1-3%	S	Mod		Idle	Corn,bans,squash	Level & spread water.	70	?				
71	7	1-2%	S	Mod		Idle	Corn,uash	Contour list.	2					
71	8	1%	S	Mod	Ave	Corn	Corn,uash	Contour list.	1					
71	9	1-2%	S	Mod	Ave	Corn,squash,melons.	Cornquash,beans.	Contour list.	1					
71	10	1-10%	FS	S		Idle	Nati	Abandon	2					

Table IX (Continued)

Location Quad No.	Tract No.	Topography	Soil*	Erosion**	Yield	Present Crops	Suggested Crops	Recommendations	Cost of Treatment: Present Acreage	Present Cost per A	Present Total Cost	Potential Acreage	Potential Cost per A	Potential Total Cost
19	1.9	1-2%	SL	S1		Idle	Orch,Corn,Veg.	Border potential	1			1	$10.00	$ 10.00
19	1.10	1%	CL-C	S1		Idle	Corn,beans	Repair borders	4	$ 6.00	$ 24.00			
19	2	1%	SCL	S	Good	Corn,squash, melons.	Corn,beans,melons.	Erosion control	50	?				
19	3	1-2%	S	Mod	Good	Orch,melons,corn.	Corn,veg,orch.	None	6					
19	3.1	1%	S	Mod	Good	Melons,corn.	Corn,melons,veg, orch.	None	3					
19	3.2	1%	S	Mod	Good	Melons,corn.	Corn,beans,melons, orch.	None	8					
19	3.3	1%	S-SL	S1	Good	Corn,squash.	" " "	None	3					
19	3.4	1%	S-SL	S1	Good	Corn	" " "	None	3					
19	3.5	1%	SCL	S1	Good	Corn,melons.	" " "	None	4					
19	3.6	1%	CL	S1	Ave	Corn,buans	Corn,beans.	None	4					
19	4	1%	SL-CL	Mod		Native	Corn,squash,beans.	Level and border				50	$18.00	$900.00
19	5	5%	S	S1	Very good.	Alf,orch,corn.	Orch	Storage and border	32			5	10.00	50.00
19	6	1-5%	S	Mod	Good	Alf,orch,corn,veg.	Same	Furnish storage	33			15	15.00	225.00
19	7	1-10%	S-SL	S	Good	Corn,veg.	Corn,veg,orch.	Terrace, erosion cont.	2	$30.00	$ 60.00			
19	8	1-3%	S-SL	Mod	Good	Corn,orch,veg.	Same	Repair borders	9	?	?	3	20.00	60.00
19	9	5%*T	S	Mod	Good	Orch,squash,melons.	Same	Erosion control storage.	3	6.00	18.00			
19	10	5-6%T	S	S	Good	Orch,veg,corn.	Same	Repair terraces	7					
19	10.1	10-15%T	S	S	Good	Orch,veg,corn	Same	Divert flood water.	8					
19	11	1-2%	SL	S1	Ave	Corn,idle	Corn,veg,orch.	Storage border land	7	15.00	105.00			

Table IX (Continued)

Location Quad No.	Tract No.	Topography	Soil*	Erosion**	Yield	Present Crops	Suggested Crops	Recommendation	Cost of Treatment: Present Acreage	Present Cost per A.	Present Total Cost	Potential Acreage	Potential Cost per A.	Potential Total Cost
71	20	1%	SCL	Sl		Idle	Corn,squash,beans.	None	3					
71	21	1%	SCL	Sl		Idle	Corn,beans.	None	2					
71	22	1-3%	S-SL	Sl		Idle	Corn,squash,melons.	Border & level.	2	$18.00	$ 36.00	5	$18.00	$ 90.00
71	23	1%	SCL	Mod	Ave	Corn	Corn,oats, squash.	Border potential (40A)	4			60	15.00	600.00
71	24	1-2%	S	Mod		Idle	Corn,squash	Spread water.	8	10.00	80.00			
71	25	1%	S-SL	Sl	Good	Veg,orch,alf.	Same as present	None	35					
71	28	1-3%	S-Sl	Mod	Good	Corn,idle,grass.	Corn,veg,clover.	Plant windbreaks.	10			5		
71	29	1-3%	S-SL	Mod	Good	Veg.	Veg.	Check gully	2					
71	30	1%	S-SL	Mod	Ave.	Idle,orch.	Corn,veg,orch.	Contour list.	6					
71	31	1-3%	S	Mod	Ave.	Corn,squash,idle.	Corn,squash.	Spread water.	10	$ 5.00	$ 50.00			
71	32	1-2%	SL	S	Ave.	Corn,grass.	Corn,veg,orch.	None	3					
72	11	2-3%	S-SL	Mod	Ave.	Corn.	Corn,beans,melons.	Spread water	2					
72	12	1-2%	S-SL	Mod	Ave.	Squash.	Corn,squash.	Contour list	1					
72	13	2-3%	S-SL	Mod	Ave.	Corn,squash.	Corn,beans,melons.	Spread water. Contour list.	6					
72	14	1-2%	S-L	Mod	Ave.	Corn	Corn,squash	Divert water. Contour list.	7					
72	15	0-1%	S-L	Mod	Ave.	Corn.	Corn,squash.	Level. Contour list.	3					
79	1	1-1.5%	S-SL	Mod.		Idle		Abandon.						
79	2	1%	SL-CL	Mod		Idle	Corn,beans,squash.	Spread water, contour list.	3					
79	8	1%	S	Mod	Ave	Corn	Corn,beans,melons.	Contour list.	2					
79	9	1-1.5%	S-SL	S	Ave	Corn,idle.	Corn	Contour list.	2					

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Table IX (Continued)

Location Quad No.	Tract No.	Topography	Soil*	Erosion**	Yield	Present Crops	Suggested Crops	Recommendation	Cost of Treatment: Present Acreage	Present Cost per A.	Present Total Cost	Potential Acreage	Potential Cost per A.	Potential Total Cost
79	10	1%	S	Mod	Good	Corn	Corn,squash.	None	1					
80	3	1%	S-SC	Mod		Idle	Corn,elf,grass.	List	15					
85	1	2%	S-SL	Mod	Ave	Corn	Corn,melons,squash.	Spread water	3	$ 5.00	$ 15.00			
85	1.1	1%	S	S	Ave	Corn	" " "	3' border to check erosion.	9	25.00	225.00			
85	1.2	1-2%	S-SL	Mod	Ave.	Corn,idle	" " "	Contour list. Border 25 Acres	35	25.00	625.00			
85	1.3	1%	S-SL	Mod	Ave.	Corn.	" " "	Border	3	25.00	75.00	6	$25.00	$150.00
85	1.4	1%	S-SL	Mod	Ave.	Corn,idle	" " "	Border 5 Acres. Contour list.	8	25.00	125.00			
85	2	1%	S-SL	Mod	Ave.	Corn,idle	" " "	Contour list.	3					
85	3	1-2%	S	Mod	Ave.	Corn	" " "	Contour list.	1					
85	4	1%	S	Mod	Ave.	Corn	" " "	Contour list.	1			1		
85	5	1%	S	S	Ave.	Corn	" " "	Contour list	3					
85	6	1%	S	S	Ave.	Corn	Corn,beans,squash.	" "	3					
85	6.1	1-2 %	SCL	Mod	Ave.	Corn	" " "	" "	5					
85	6.2	1%	S-SL	Mod	Ave.	Corn	" " "	" "	8					
85	6.3	1-3%	S-SL	S	Ave.	Corn	Corn,squash	" "	15					
85	7	1%	S-SL	S		Idle	Corn,squash,beans.	" "	1					
86	2	1%	S-SL	Mod	Ave.	Corn	Corn,squash,melons.	" "	1					
86	4	1-2	S-SL	Mod		Idle	Corn,squash,beans.	" "	3					
87	1	3%	S-SL	Sl		Native	Corn,orch,veg.	Develop water, & storage. Level & border.				10	$25.00	$250.00

Table IX (Continued)

Location Quad No.	Tract No.	Topography	Soil*	Erosion**	Yield	Present Crops	Suggested Crops	Recommendation	Cost of Treatment: Present Acreage	Present Cost per A.	Present Total Cost	Potential Acreage	Potential Cost per A.	Potential Total Cost
95	3	.5%	FSL	Mod		Idle	Grain sorghums,Corn.	Strip cropping. Contour list.	50					
95	5		S-L S	S		Melons	Melons.	None	1					
95	7	2.5%	SL	Mod	8 bu	Melons,corn.	Beans,corn,melons.	Contour list.	4					
95	8	2%	SL	Mod		Idle	" " "	" "	3					
95	9	2.3%	SL	Mod	8 bu	Corn,melons.	" " "	" "	3					
95	10	1.5%	SL	Mod	10 bu.	Corn, melons.	Corn,beans.	Strip crop, contour list.	8					
95	11	1.5%	SL	Mod	8 bu	" "	Beans,corn,sudan grass.	Contour list.	5					
95	12	3.5%	SL	Mod		Melons	Melons,corn,beans	Contour list.	4					
95	13	1.5%	SL	Mod	8 bu	Corn,melons.	" " "	" "	30					
95	14	.5%	SL	Mod	8 bu	Corn	" " "	" "	8					
95	15	.5%	LS	Mod	8 bu	Corn	" " "	" "	3					
95	19	4%	S-LS	S	5 bu	Corn	Sorghum,corn,beans	" "	3			3		
95	20	1-5 %	SL	Mod		Idle	Corn,beans,melons.	" "	3					
95	21	1.5%	LS-SL	S	10 bu	Corn	Beans,corn,sorghum.	Contour list, level and border.	10	$20.00	$200.00			
95	22	.5%	SL	S	8 bu	Corn	Corn	Contour list.	5					
96	1		SL	S		Idle	Corn,beans.	Contour list.	6					
96	2	1%	SL	S		Idle	Beans,melons,corn.	" "	4					
96	3	2%	SL	Mod		Idle	Sorghum,corn,beans.	" "	5					
96	4	3%	CL-C	Mod		Idle		Abandon.	4					
96	5	1%	SL	Mod	Poor	Corn	Corn	Level and border.	30	$18.00	$540.00			

Table IX (Concluded)

Location Quad No.	Tract No.	Topography	Soil*	Erosion**	Yield	Present Crops	Suggested Crops	Recommendation	Cost of Treatment: Present Acreage	Present Cost per A.	Present Total Cost	Potential Acreage	Potential Cost per A.	Potential Total Cost
96	6	1%	SL	S	Poor	Corn	Corn,beans.	Level and border.	20	$18.00	$360.00			
96	10	.5%	SL	S		Idle	Corn.	Contour list.	8					
96	12	.5%	L	S	5 bu	Corn	Corn,beans.	" "	2			4		
96	13	.5-1%	LS-S	Mod	8 bu	Melons,corn.	Corn,beans,melons.	" "	2			4		
96	16	3.5%	SL	S	10 bu	Corn,melons.	Sudan grass,corn, beans.	Border and level	8	$35.00	$ 36.00	5	$35.00	$175.00
96	17	2.5%	LS	Mod	Poor	Corn	Sorghum,beans,melons.	" " "	5	40.00	200.00			
96	18	1.5%	SL	S	5 bu	Corn	Corn	Contour list.	3					
96	23	1.5%	SL	S	Poor	Corn	Corn,bea	Contour list.	5					
96	27	1.5%	SL	S	5 bu	Corn	Corn,melons,b.	Border and level.	5	15.00	75.00	2	15.00	30.00
96	33	.5%	C-CL	S	5 bu	Corn	Melons,corn,beans.	" " "	5	15.00	75.00			
96	34	2.4%	SL-S	Mod	Poor	Corn	Corn,beans.	Contour list.	3					
96	35	2%	SL	Mod	15 bu	Corn	Corn,beans.	" "	4					
96	36	.5-1%	CL-S-LS	Mod	15 bu	Corn,melons.	Beans,corn,melons.	None.	60					
96	37	1-3%	LS	Mod			Abandon	Abandon	5					
96	38	2.5%	FSL	S		New farm	elons,corn,beans.	None				2		
								Total - -	2,150		$3,936.00	238		$3,045.00

3. Woodland Resources:

a. Present Resources:

(1) Acreage and Location:

Because of the boundary changes that were effected in this Unit, a large acreage of woodland which was originally in Unit No. 3 has been withdrawn and is now in Unit No. 1. Because the area is principally grassland or browse, with only a small percentage of woodland stands, this was a severe loss to the inhabitants of Unit No. 3 . However, nearby areas with adjacent units' ample woodland products will be available.

(2) Site, Class and Condition:

The woodland acreage over the present boundaries amounts to 77,893 acres, all of it falling in Site 2 or 3 and Condition "B" or "C". The following table graphically explains this relationship:

Table X Woodland by Site Class & Present Condition

Condition	Site 1	Site 2	Site 3	Total
A - (Good)	0			
B - (Medium)	0		5,596	5,596
C - (Poor)	0	6,745	65,552	72,297
Total - -	0	6,745	71,148	77,893

(3) Available Products:

Woodland products available in the area are only in limited quantities and are only in restricted localities. This is due to several factors. In the first place, woodland areas have been limited and the present population has, through severe overuse, removed practically all available dead material and are at present removing live material. Only a restricted area on Grey Mountain furnishes a source of wood and wood products. Hogan material and posts and fences are not available within the Unit but will be found on adjacent Units. In this regard, there has been an area set aside on Black Mesa for use by Hopi Indians. The present practice is for truck drivers, especially Hopi, to go to various outlying stands to obtain fuel and posts. This has resulted in severe depletion of woodland resources and a great deal of controversy by the Navajos. To alleviate this condition, the area on Black Mesa was set aside for Hopi use, and Navajo use is to be restricted in this area. For the most part woodland products available within Unit No. 3 are a negligible factor as a resource.

The general location and character of woodland stands in the Unit present severe problems. For the most part, the stands are located on rather easily eroded soils and through misuse much of the duff and litter has been washed away, creating adverse conditions in regard to seed bed. From an ecological standpoint, the woodland stands are located on sub-marginal land. A shallow,

spotty soil cover, a low rainfall and high water runoff present a poor ecological habitat for woodland stands. Only on Gray Mountain is climate suitable for dense woodland. Misuse through poor cutting and grazing practices, together with a low rainfall have resulted in a lack of reproduction and regeneration of woodland stands.

(4) Grazing Value:

The grazing value of woodland stands within the Unit is relatively low as compared with other vegetative types. They serve as a grazing resource to the extent of approximately five percent of the carrying capacity of the Unit. For the most part, species found in the understory are relatively scattered and are of low palatability.

(5) Watershed Value:

Watershed values of woodland stands are quite important on Grey Mountain in the denser stands. In the scattered stands, it may become important primarily because of lack of other vegetation. The steep slopes and the easily eroded soils further emphasize the importance of woodland as watershed protection.

(6) Wildlife:

Grey Mountain furnishes the only wildlife habitat of importance in woodland stands.

b. Utilization of Present Resources:

(1) Cutting Practices:

Cutting practices throughout the Unit have been detrimental to woodland stands; clear cutting, excessive overuse over wooded areas, excessive use of outlying stands, and other bad practices have resulted in severe depletion of woodland resources.

(2) Woodland Pests, Diseases and Rodents:

As a general rule, damage to woodland stands by pests, diseases and rodents is not severe. Dendroctonus and ips are ~~not~~ present but not common within woodland stands and no severe damage is present. Leaf-gall and twig-miners were noted throughout the stands, especially outlying stands, but damage is not considered serious. Mistletoe is present on much of the juniper but is doing damage only by reducing the vitality of the plants, making them susceptible to insect and fungi infections. Juniper rust is present, especially in outlying stands where as much as 30% of the trees are affected. Damage is created by a lowered resistance of trees to further infections of fungi and disease.

As was previously pointed out, the woodland stands are as a rule growing under adverse conditions far from optimum. This factor alone may be responsible for insect invasion.

Porcupines are doing severe damage to pinon by removal of bark and increasing insect and disease hazard. Chipmunks, rats mice and other animals are responsible for the collection of a large amount of pinon nuts and juniper berries, creating adverse conditions for the establishment of reproduction. The extent of this damage is difficult to measure.

(3) Damage to Woodland:

Fire hazard within woodland in this Unit is relatively low, primarily because of the scattered character of woodland and the lack of under-growth. Abrasion from blowing sand and the removal of soil from around the roots of the trees has been an effective factor in lowering the resistance of trees to insect and fungus disease. Grazing damage has been excessive over large areas. Improper seasonal use and over-stocking have resulted in severe damage to reproduction, not only ruining the seed bed but also killing and damaging young growing plants,

c. Marketing:

Woodland products in this area return an income through the sale of wood and pinons. Total income from this source was $6,536.80; $442.62 from wood sales and $6,094.18 from sale of pinons. With the limited amount of woodland in the area this is is a relatively high income figure and the factor of Indians going into adjoining Units to pick pinons or obtain fuel wood must be kept in mind. To what extent this is carried out is not known.

Fuel wood bears a relatively high value in sale, trade, and barter among the Indians themselves.

4. Economic Status of the People:

a. Income:

Table XI — Cross Income

Item	Commercial	Non-commercial	Total	Percent
Wages	$122,245.34		$122,245.34	35.9%
Livestock	70,687.98	$ 29,626.00	100,313.98	29.4%
Agriculture	962.88	97,701.90	98,664.78	28.4%
Rugs	10,839.34		10,839.34	3.2%
Miscellaneous	8,739.47		8,739.47	2.6%
Total - -	$213,475.01	$127,327.90	$340,802.91	100.0%

The gross income for the Unit in 1936 was $340,802.91, or a per capita income of $174.00.

Under "Wages" a gross figure of $122,245.34 is derived, classified as follows:

Soil Conservation Service Irregular -	$36,304.07
Construction - - - - - - - - - - - - - -	10,988.87
Roads - - - - - - - - - - - - - - - - -	5,178.23
Irrigation - - - - - - - - - - - - - - -	5,478.58
E. C. W. - - - - - - - - - - - - - - - -	17,760.71
Agency, Regular - - - - - - - - - - -	19,867.85
Agency, Irregular - - - - - - - - - - -	6,984.76
Voucher Payments - - - - - - - - - - -	18,064.27
Traders - - - - - - - - - - - - - - - -	3,118.00
Total - - - - -	$122,245.34

Some of these items are unavoidably in error. Soil Conservation Service Irregular includes principally work at Moenave and it is felt that some Indians from contiguous Units, especially Land Management Unit No. 1, receive benefits from this source. Likewise Irrigation, Roads, Construction, Agency Irregular, E. C. W., and Voucher Payments were handled from the Western Navajo Jurisdiction office and similar offices at Tuba City and, although some of the work was located in adjacent Units; namely, Kaibito and Shonti, and Indians from the adjoining districts received some direct benefit through wages or payments for meat etc. for the school at Tuba City, such payments were charged to Unit No. 3. The extent of the error in these figures as charged to Land Management Unit No. 3 is not known and to which district the error should be credited is unknown. It is therefore necessary to charge wages as they have been distributed in the preceding breakdown. Income from Agency Regular and Traders is felt to bear a rather close relationship to actual benefits.

Gross commercial income other than wages is divided as follows:

Table XII	Gross Commercial Income			
LIVESTOCK PRODUCTS:		$70,087.98		77%
Sheep,Goats,lambs	$12,512.95		18%	
Cattle	6,866.89		10%	
Wool and Mohair	35,487.46		50%	
Pelts	800.65		1%	
Meat	15,020.03		21%	
AGRICULTURAL PRODUCTS:		$ 962.88		1%
Corn	923.48		96%	
Melons & Squash	10.40		1%	
Potatoes	20.00		2%	
Peaches	9.00		1%	
RUGS:	10,839.34	10,839.34	100%	12%
MISCELLANEOUS:		8,739.47		10%
Pinons	6,094.18		70%	
Jewelry & Baskets	2,202.67		25%	
Wood	442.62		5%	
Total - - -	$91,229.61	$91,229.61		100%

Gross commercial income exclusive of wages amounted to 20% less than gross non-commercial income, $127,327.90. This amount represents crops and livestock produced and consumed by the Indians within the Unit.

The following table shows non-commercial sources of income divided into the various items:

Table XIII — Gross Non-Commercial Income

Item	Gross Acres	Yield Per A (lbs)	Total Production	Quant. Sold to Trader	Quantity Consumed	(a) cwt	Gross Value
Corn	1,055	1,120	1,181,600	37,630	1,143,970	3.06	$35,005.48
Alfalfa	9	4,000	36,000		36,000	1.67	601.20
Melons & Squash	65	4,000	260,000	208	259,792	3.44	8,936.84
Beans	4	300	1,200		1,200	7.79	93.48
Vegetables	108(1)	(1)	280,800	400	280,400	(1)	14,523.88
Orchard(2)	72	6,000	432,000	100	431,900	(2)	38,541.02
Agricultural Products							$97,701.90
Sheep (8642 head @ $3.00)							25,926.00
Cattle (185 head @ $20.00)							3,700.00
Livestock Products							29,626.00
Total							$127,327.90

(1) Includes potatoes, onions, carrots and tomatoes, acreages equal. Yield: potatoes, 1-1/2 tons; onions, 2 tons; others, 1 ton. Value per cwt: potatoes, $3.77; others, $5.66.
(2) Peaches, $9.17 cwt; apples, $6.93 cwt; pears, $6.93 cwt (est.).

The above table does not include the crops grown on the Government farm at Tuba City (365 acres) and idle farmland. Yields

and acreages are obtained from agronomic estimates and prices per hundredweight upon the price the Indians would have to pay if they purchased the articles from the trader.

b. Consumption:

Consumption in the Unit in 1936 amounted to $269,848.02. Of this, $127,327.90 was non-commercial, home produced and consumed. The remainder, $141,520.13, was purchased from the traders. This figure on consumption eliminates as nearly as possible all trade with non-Indian trade. At Tuba City this factor would impart considerable error to the figure.

Food consumption amounted to $226,065.45. Of this, $127,327.90 was home produced and $98,737.55 or 44% was purchased from the trader. The latter figure may be further subdivided to include those products that could not be produced in the area, $76,906.21 or 78%, and those products that might be termed producible provided adequate agricultural land were available, $21,831.34 or 22%. Of the amount purchased from the traders slightly more than 1%, $1,505.50, was produced within the Unit, sold to the trader, and repurchased by the Indians, $97,232.05 was imported into the area by traders.

Of the amount of food imported into the Unit, $97,232.05, a certain amount could be produced in the Unit provided the agricultural land were available and the proper crops grown. $21,831.34 is termed producible within the area. The present imports into the area, value and acreage of agricultural land

needed for their production, based on agronomic yield estimates, are shown in the following table:

Table XIV — Acreage Required for the Production of Producible Imports

Crop	Pounds Imported	Value	Yield A/lb.	Acreage Req.	Present Acreage Available
Corn	3,900	$ 119.50	1,120	3	Idle Land 423 acres
Oats	32,297	1,078.80	384	84	Potential 204 "
Alfalfa	159,495	2,669.58	4,000	40	627 "
Beans	1,082	84.26	300	4	
Potatoes	40,002	1,509.18	3,000	13	
Melons	56,106	1,931.67	4,000	14	
Onions	57,776		2,000	29	
Peaches	925	84.80	6,000)	2	
Apples	13,334	923.53	6,000)		
Wheat	466,017	13,106.88	720	647	
Total - - - - -		$21,831.34		836	627

The above table becomes important in justifying the expenditures on farmland subjugation or development. Based on the above figures, approximately $22,000.00 of produce are imported into the area. Based on agronomic estimates of yield, 836 acres of land would produce these imports on an average annual return of $26.11 per acre. However, in considering the advisability of the production of such crops, suitability of the land must

be borne in mind. Dry farm, for instance, will not produce alfalfa hay in this area. Production of potatoes is very questionable.

II. SUB-UNITS:

At the time the survey was made, the principle of dividing the area into sub-units for ease of description, planning or other reasons, was practiced but such sub-divisions were made by the various branches for their own purpose and an attempt was not made to divide the area according to the concensus of opinion of the entire study group. It was therefore found that Range Management had twenty sub-units divided on topographic and range usage. Agronomy and Human Survey Section each had five sub-units which coincided. Soils, Forestry, Biology and Engineering considered the Unit as a whole. In view of the above facts, it would seem unnecessary to attempt a correlation of the various basic data obtained by the various branches according to sub-units and in this report would impossible. The area is considered as a whole.

III. EFFECT OF HUMAN ACTIVITY ON ENVIRONMENT:

A. DESTRUCTION OF VEGETATION:

1. Improper Range Management:

Human activity in the area has shown profound effects upon vegetation. Vegetation in range areas has been essentially destroyed, or the density of the vegetative cover has been

definitely decreased by improper range management practices. In the vicinity of hogans, perennial species have been killed out and annual species have taken their places as results of improper herding and overstocking.

2. Improper Woodland Management:

Woodland areas are at the best existing under adverse ecological conditions, being in a low rainfall belt with shallow soil cover, for the most part. Scattered stands are prevalent throughout the area. The improper use of this resource has resulted in the devastation of forest stands. In many cases, stands of woodland have been completely killed out by clear cutting and in others, use has been so severe as to render the trees highly susceptible to insect and fungus invasions.

B. CHANGE OF VEGETATION:

1. Indicators of Overgrazing:

In large areas there is a predominance of plants indicative of overgrazing and misuse. Areas which were once covered with palatable range species are now covered with snakeweed, yellow brush, three-awn, and other species of little, or no, forage value. This is especially true of areas around permanent waters and is quite noticeable west of the Cap and Cedar Ridge where the Indian Service, about ten years ago, constructed reservoirs. In this area it is reported that until the construction of the reservoirs the area was covered with a rather dense cover

of blue grama, a very important range species. Today, a rather low density, chiefly of snakeweed, is present. Such use has resulted in destruction of natural resources.

2. Available Forage:

Together with indicator plants, the actual condition of the vegetation is testimony of misuse in the area. Browse species over the entire area, with the exception of under-utilized portions, have been browsed so severely as to cause damage to the individual plants and if continued, will result in a decrease in the protection of forage over the area.

In all cases where misuse has been carried on over an extended period of time there has been a reduction in the amount of available forage. In some cases, the density of the vegetative cover has not been materially reduced, but because of the increase in the percentage of species of low palatability, or unpalatable species, the available forage is less than was originally on the area.

C. DESTRUCTION OF FARM RESOURCES:

1. Improper Use of Water:

The farming resources of the area have, to some degree, been destroyed by improper farming practices. The improper use allowing water to concentrate in certain areas, allows for a concentration of alkali, thereby creating a condition unsuitable for the production of crops and the ruining of otherwise valuable farmland.

2. Improper Cultural Methods:

Unchecked, erosion removes valuable fertile topsoil from farmland and decreases the productivity of farming resources. Improper cultural methods have been a contributing factor to erosion. Fields are not strip-cropped and are allowed to remain unprotected by any cover during the winter, allowing the wind to have free access to the fields. The cultural methods and the destruction of farming resources is more pronounced on the fields cultivated by Navajo than on those cultivated by Hopi farmers.

D. DESTRUCTION OF WILDLIFE HABITAT:

The wildlife habitat over the entire area has been destroyed or made less valuable by the mismanagement of the various natural resources, principally range and forest. By the decrease in vegetative cover and the killing out of species that furnish feed and protection for wildlife, the habitat has been materially reduced in value.

PART TWO

ESTABLISHMENT OF PROPER LAND USE

L. NECESSARY ADJUSTMENTS:

A. PROPER RANGE CONTROL:

1. Grazing Dates:

Lower Basin and Gray Mountain are recommended for grazing as winter range from September 12 to March 15. Needmore Sub-unit is recommended for grazing during the summer season and dates have been set so that the former two sub-units will care for the livestock that are in Needmore Sub-unit during the summer months. The rest of Unit No. 3 is recommended for yearlong usage but will be regulated to some degree by the development of livestock water in the Bodaway House-Cedar Ridge area. If permanent water is not developed in this area, a system of seasonal use will have to be worked out whereby the area is used during seasons when water is available and the stock moved to Tuba City and the Gap during the dry weather. If at all possible, water should be developed so as to hold trailing of herds to a minimum.

2. Proper Class and Numbers of Livestock:

Either sheep or cattle may be used as the proper class of stock on the entire area but in either case, productive stock should be used to stock the range. On Ward Terrace and smaller areas around Cameron a predominance of coarse grasses creates a condition whereby the range would be better utilized by cattle

than sheep. However, the carrying capacity of these areas is very small. The entire stocking of the area is not to exceed the carrying capacity as established by the Extensive Grazing Survey in 1935, 47,938 sheep units yearlong. This limit is established using a forage acre requirement of two and one-half forage acres per sheep unit yearlong.

3. Livestock Adjustment:

The livestock population of Unit No. 3 is 3,974 sheep units yearlong in excess of the carrying capacity. A reduction of this number of sheep units will be necessary in order to bring the present stocking down to the carrying capacity of the area. Such adjustment should follow in the following order: horses, steers, wethers, and unproductive stock; goats; and productive stock of undesirable market type and quality. The allowance of six horses per consumption group is recommended for the Unit.

4. Bucks and Bulls:

The number of sires in breeding herds should conform to the ratio of four bulls per hundred breeding cows and three rams per hundred ewes. A ram pasture has been constructed on Coal Mine Mesa large enough to care for seven hundred rams from January 1 to November 15. Supplementary feeding of the rams will be worthy of consideration just previous and during the breeding season. Proper management of the ram herd, including herding, salting, etc., deserves special consideration inasmuch as this

herd may become very important in the demonstration of proper management methods.

No bull pastures for the Unit are recommended at present, although in future years this may be worthy of consideration after management has been improved to such an extent that bulls can receive proper attention.

5. Breeding and Lambing:

The breeding season for sheep is recommended from November 15 to January 1. This will bring lambing season between April 15 and June 1, during which time there should be available a relatively large supply of green succulent feed which will increase the amount of milk available for lambs. Special consideration in the handling of the breeding herd will be necessary during lambing season.

6. Shearing:

Shearing in the Unit is recommended to start June 1 and continue until completed, with the rams being shorn last. Central power shearing plants may be a desirable feature of the range improvement program in future years, but at present they are not recommended.

7. Water Developments:

The development of water in the Bodaway House-Cedar Ridge area is essential for proper range use of this area. The development and maintenance of supplies in other parts of the Unit are

important features in a proper range management plan for the area. Such developments and maintenance that are necessary to establish proper range usage, including distribution of stock and making available forage resources, should be constructed as quickly as funds and time permit. For a detailed list of such projects see Construction Program.

8. Livestock Distribution and Movements:

The concentration of livestock around population centers, agricultural areas and permanent water should be eliminated as quickly and completely as possible. Movements of livestock should be kept to a minimum to reduce the devastating effect of trailing and trampling. Salting, herding and water developments that are necessary to obtain proper livestock distribution are objectives to be held in mind in a proper land management program.

9. Protection from Poisonous Plants:

Protection against losses from poisonous plants will consist primarily of proper herding methods and proper seasonal use of the areas. The principal plant involved in such precautions is loco, which affects horses more than other classes of livestock. Eradication of loco is not recommended, primarily because of the large areas affected and the fact that horses are the most important class of stock affected. Through proper herding methods, losses can be held to a minimum.

10. Control of Livestock Pests:

The present practice of annually dipping sheep and goats in order to reduce livestock pests, especially lice, should be continued. This also serves as a means of obtaining information for livestock statistics. Proper herding methods and bedding out will aid materially in the reduction of damage from grub-in-the-head and other animal diseases, and at the same time improve the usage of range resources. A new dipping vat is proposed four miles west of Shinamo Altar if the reservoir is completed in that area. This consideration, however, is of secondary importance.

11. Range Rodent Control:

Rodent control is recommended in certain areas to reduce the damage, especially from prairie dogs, on range resources. The treatment of Type G-31 and re-treatment of Types G-1 and G-2 (see map) are recommended for immediate consideration. Approximately 84,000 acres are recommended for projects at a cost of approximately $11,350. Rodent control projects for ultimate consideration consist of treatment of 52,000 acres at an approximate cost of $7800. Detailed plans in regard to these projects will be found under the Construction Program. Continual vigilance on the part of the district supervisor and other personnel within the area will be necessary in order to recommend future treatment when the need arises in the area.

12. Predatory Animal Control:

Predators are not numerous enough at the present time to warrant a control program. However, in order to encourage proper herding, the scattering of sheep instead of close herding, it may become necessary to reduce the coyote population through predatory control. Likewise, a control program may become necessary in future years if the population of predators increases.

13. Wildlife Development:

Any developments along proper land use will improve the wildlife habitat of the area. Definite projects listed under the Construction Program include planting, which will benefit wildlife in the area. The planting of desilting plots, windbreaks and stream channels according to diagrams L-470, L-468, L-479 and L-350 will improve the wildlife habitat. The introduction of Scaled Quail at desilting plots which are planted and Merriam's Turkey on Gray Mountain constitute recommended wildlife introductions into the area. Legal protection for game species in the area should be continually enforced for existing wildlife. With an improved habitat, a larger population of wildlife should result in the Unit.

14. Range Waterspreading and Erosion Control:

Waterspreading possibilities in the Unit are not numerous. Two areas have been selected as feasible, two miles south of

Cameron. East of Highway 89 a 300' dike with wire spreaders will spread water on 200 acres of range land at an approximate cost of $200.00. In quadrangle 111°15' x 26°15' along the west side of the Moencopi Wash, several small dikes across gullies can be constructed to effectively spread water on 800 acres of range land at an approximate cost of $400.00.

Erosion control projects are not numerous and most of them can be completed when a reservoir crew is in the vicinity of such projects. Two projects deserving consideration can be worked as individual projects. They are EC#1, 111°30' x 35°45', and EC#1 111°30' x 36°00'. These affect 800 and 270 acres of range land respectively and the total cost is estimated at $20.00. They are of secondary importance and may serve as projects easily laid out and started.

15. Range Revegetation:

Possibilities of range revegetation are limited within the Unit. Where a sparse vegetative cover exists, there is usually high alkali content, practically no soil cover, or advanced active wind erosion, any one of which would be a limiting factor in the success of revegetation projects. Other areas have seed supplies present, which, under proper range management, proper herding methods, and proper utilization, will recover to such an extent that there will be an increase in the vegetative cover making revegetation unnecessary.

16. Deferred and Rotation Grazing:

Seasonal use and deferred and rotation systems of grazing are recommended for areas around Tuba City. Such systems will require further study before they can be put into effect.

17. Hopi Range:

It is recommended that an area on Coal Mine Mesa be set aside for Hopi use and fenced to include Hopi livestock separated from Navajo. Further study will be required to care for Hopi livestock and the selection of fences will be necessary before this area can be set aside.

18. Education and Demonstration:

Education and demonstration to the Indians as to proper range management and proper animal husbandry practices will be a necessary part of the land management program. It must be borne in mind that the process of changing present practices through education and demonstration is a lengthy and tedious process but if action is not started along these lines, it can only be expected that the program will be of longer duration. The Tuba City buck pasture will serve as a demonstration of proper herding and salting practices in handling sheep. Every effort should be made to impress the population with proper utilization range resources.

B. FARM DEVELOPMENTS:

1. Improvement of Present Farmland:

a. Subjugation:

Because of the limited supply of farmland in Unit No. 3 it will become extremely important that present resources be utilized in a manner such that maximum returns are yielded from present resources. The improvement of present cultural methods, the reduction of pests and rodents and the proper subjugation of present land are important features of this program.

Subjugation of land should be done as much as possible by the Indians themselves, and consists primarily of leveling or bordering lands. A total area of 527 acres of farmland is recommended to be treated, at an approximate cost of $8,460. This estimate includes both present and potential land to be treated, the cost on present land being $5,665, and on potential land, $2,795. The outstanding agricultural projects on farmland are as follows:

First, the expansion at Old Moenave Day School. Expansion here consists primarily of the construction of reservoirs for storage of water during the winter months. Approximately thirty acres of land are under cultivation under the present system and an increase of fifteen acres can be subjugated with additional storage. Leveling and bordering will be required at an estimated cost of $15. per acre.

Second, Pasture Canyon: Here, the source of water is from springs which are stored in the Hopi Reservoir. At prese t the water meanders through the valley, causing much loss from seepage and evaporation. A sand dune located immediately above the Hopi Reservoir has dammed the stream, causing further loss of water. It is recommended that drainage ditches be constructed in the upper portion of the canyon to make available more farmland which is now a meadow, and that 520 lineal feet of corrugated iron pipe be placed under the sand dune correcting the condition of having to clean the ditch so frequently. The subjugation of land at the head of the canyon is recommended for development, under the supervision of the superintendent at Tuba City, into a project with the school.

The Hopi Reservoir has a capacity of approximately three hundred acre feet and no spillway is provided. It is recommended to raise the dam three feet, providing a spillway. By the construction of a ditch below the Hopi Reservoir on grade with the necessary drops, losses of water from seepage and evaporation will be materially reduced and more water will be available on the farmland below the reservoir. Although this project includes some land which will be potential developments of new land, the major portion of it is for the betterment of existing land and is, therefore, discussed under Present Agricultural Resources.

The third development consists in the improvement of farms in the vicinity of Willow Springs, most of which have permanent

springs as a source of irrigation water. In most cases, additional storage can be developed at a relatively low cost for erosion control effected.

Fourth, the development at Cedar Ridge includes the bordering and leveling of forty-five acres of present farmland at an approximate cost of $25. per acre. By such construction the farmland will receive a more well distributed amount of water over the entire area.

b. Erosion Control:

Erosion control on farmland consists of small projects of spreading water more evenly on flat irrigated land, of checking head and gully erosion by dikes or similar structures, by the reduction of wind erosion by windbreak planting. Such control, as far as possible, should become the responsibility of the Indians operating the farms, as most projects are very small and the cost would be excessive if government agencies had to move a crew in to the location to complete the work. Erosion control planting, including bank protection along the Moencopi and windbreak planting on all the farms, should be encouraged.

c. Reduction of Farm Pests:

The reduction of farm pests and rodents will consist primarily of control of weeds, spraying of fruit trees, and rodent control along with improved cultural practices. White top weed and cocklebur are becoming very important pests on the farms at

Tuba City. Proper eradication methods of white top weed are recommended for immediate consideration before the damage has become excessive and before the weeds have spread further. Cocklebur and other weeds infesting the area can effectively be controlled by ploughing and cultivating. The coddling moth is doing a great deal of damage to the fruit trees in the area of Tuba City and Moenave and at present, spraying equipment is not adequate enough to care for the needs of the land. The purchase of additional spraying equipment will be necessary in order to control this pest effectively.

Rodent control of 2350 acres around farmland at Cedar Ridge and Coal Mine Mesa, at an approximate cost of $350, is recommended in order to reduce rodent damage to crops. Further rodent control in the vicinity of farmland may become necessary in future years and it should be the part of the district supervisor to report any such increases of rodent population for rodent control in the future.

d. Cultural Practices:

An improvement of cultural practices for the area will be necessary in order to obtain maximum returns from farm resources. Fall ploughing, especially deep listing, will tend to reduce wind removal of topsoil and at the same time reduce damage from insects such as grasshoppers and cutworms. Methods of harvesting and storing can stand much improvement. Ratproof

storages are recommended for the entire area, to reduce losses from rodent infestation and spoilage. Improvement of the quality of crops through seed selection is recommended for the area.

2. Potential Farmland:

The development of potential farmland in this Unit consists primarily of additional acreage at existing farms and in many cases will require little or no subjugation cost, and for the most part can be done by the Indians themselves. The largest tract of potential land is at the Lower Moencopi damsite. The Indian Service has already constructed a diversion and put in two main canals with a thirty second-foot capacity headgate. The only cost of development at this location will be the construction of lateral ditches, the bordering and leveling of the land and the raising of the diversion dam approximately three feet. Planting in the channel of the Moencopi Wash to prevent sloughing is recommended.

Although some two hundred forty acres of potential land are available at this location, the water supply is rather questionable, especially during the growing season from May 15 to June 15. It is, therefore, recommended that only fifty acres be developed first, and additional land developed later if the water supply is adequate to care for further development. Cost estimates on the project will be found in the Construction Program. This project, along with land at Pasture Canyon and Moenave, constitute the major portion of potential new development within Unit No. 3.

3. Education and Demonstration:

Education and demonstration will become an important part of the proper use of farmland in the area. Education as to the proper method of handling water, proper cultural methods will be essential in order to receive maximum returns from farmland. The government farm located at Tuba City and the Moenave Demonstration Area will serve as locations for the dissemination of knowledge regarding proper agronomic methods.

C. WOODLAND MANAGEMENT:

1. Cutting and Marking:

All green material used in this area will be taken under permit after the material has been marked by a representative of the Forestry Division. Cutting practices conducive to proper woodland management are recommended for the area. Clear cutting, or the removal of stands of trees, is not to be practiced. Dead and down material for fuel wood may be taken without permit but in any case, utilization of forest resources will comply with areas set aside by the Forestry Future Use Map.

2. Grazing in Woodland Stands:

Grazing in woodland stands will conform to proper range management practices including proper number and distribution of livestock, proper herding methods and either bedding out systems or multiple corral systems, which will allow for the best use of forest resources, allowing for reproduction, and reducing grazing damage to a minimum.

3. Fire Protection:

A skeleton system of fire protection is recommended for the area, set up under the direction of the district supervisor in such a way that it would fit in with the Reservation-wide fire protection system. Only limited stands of woodland are of such density as to present severe fire hazards and an alaborate fire protection system is not necessary.

4. Reforestation and Afforestation:

Reforestation possibilities within the Unit consist of woodland planting along the Little Colorado River and Moencopi drainage. They are very limited in extent and should be done, at least at first, on an experimental basis. No afforestation is recommended for the area.

5. Reduction of Woodland Pests:

The improvement of woodland stands to reduce the damage from insects and fungi can be carried out most effectively through cutting practices.

D. EROSION CONTROL PLANTINGS:

Erosion control planting over the entire area will consist primarily of windbreaks around farmland, and bank protection planting along the Moencopi Wash. Any woodlot planting along the Little Colorado River and along the Moencopi drainage will also serve as erosion control plantings. Planting possibilities are discussed under the Construction Program.

E. ADJUSTMENT OF WAGES:

Approximately $125,000. in income was spent in Unit No. 3 in 1936. To reduce this amount materially in a short period of time is very likely to cause social reactions which are very undesirable. At the same time, a more equitable distribution of wage income is necessary in order that families with a low income can receive the benefits of wage income. If a reduction of wages is made, such should be carried over a long enough period of time so that extreme social changes will not take place.

II. CONSTRUCTION PROGRAM:

A. RANGE DEVELOPMENT:

1. Livestock Water:

Range development consists primarily of the development and maintenance of livestock water. The projects listed below include the type of work, the area affected and the approximate cost, listed in order of priority. Miscellaneous range developments, such as water spreading and erosion control, and reduction of range rodents, are also included and have been listed in the order of priority within their separate classifications.

The following projects include all projects necessary for proper land use at the time of the survey that were found by the study group. Since then some of the prljects have been completed but, because of a lack of knowledge which ones have been completed, all projects are listed.

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Table XV — Range Water Developments and Maintenance

Quadrangle	"S	"W	Number	Type	Purpose	Area Serviced	CC SYL*	RM Just'f'n @ $2.50 per SYL per Ann.	Other Just'f'n	Est. Cost	Type of Work Recommended
111°15' 36°15' Willow Springs	4	7-3/4	3A-203	Maintenance	Stock Distribution	15,000	70	$ 175.00	$ 50.00 DM**	$ 150.00	Put in rock and concrete aprons around troughs.
111°15' 36°00'	17	8-1/4	3A-62			None			35.00	10.00	Obtain hand pump from this well, which is off Reservation.
111°00' 36°15'	16-3/4	14	3A-17	Maintenance	Stock Distribution	7,000	112	280.00		36.00	Repair apron around trough.
111°00' 36°00'	6-3/4	9-1/2	3A-21	Maintenance & Development	" "	10,000	640	1,600.00		No est.	Drill hole connecting troughs lower.
111°00' 36°00'	1/2	5-3/4	3A-27	" "	" "	18,000	480	1,200.00	50.00 DM	270.00	Rebuild troughs. Install float.
111°00' 36°00'	6-1/4	9	3A-28	" "	" "	12,000	320	800.00	50.00 DM	540.00	Repair troughs. Pour additional troughs for pasture.
111°00' 36°00'	3-1/2	4-3/4	3A-149	" "	" "	10,000	300	750.00	50.00 DM	540.00	" "
111°15' 36°00'	10	5	3A-141	" "	" "	12,000	720	1,800.00	25.00 DM	1,215.00	Complete project. Pour two sets of troughs.
111°15' 36°00'	15	8-1/4	3A-60	Maintenance	" "	10,000	320	800.00		13.50	Replace handle & diaphram of pump.
110°45' 36°00'	14-1/2	13-3/4	3A-153	Maintenance & Development	" "	9,000	216	575.00	No est.		Deepen well & complete project.
111°30' 36°00'	12	8-1/2	3A-73	Maintenance	" "	8,000	288	720.00		490.00	Rebuild dam.
111°00' 36°15'	4	6	3A-88	Development	" "	5,000	80	200.00	10.00 DM	35.00	Install hand pump.
111°00' 36°30'	12-1/4	3-1/4	3A-97	"	" "	10,000	120	300.00	10.00 DM	35.00	" " "
111°00' 36°15'	1/4	12-3/4	3A-7	"	" "	5,000	40	100.00	10.00 DM	35.00	" " "
111°15' 36°30'	14-1/4	13-1/2	3A-162	Maintenance & Development	" "	10,000	200	500.00	50.00 E.C.***	430.00	Raise dam 4'. Fence desilting plot.
111°45 36°15'	2	2-3/4	3A167	Maintenance	" "	6,000	240	600.00	No est.		Salt to facilitate tramping.

*CC-SYL = Carrying Capacity Sheep Units Yearlong. ** D.M. = Domestic use. ***E.C. = Erosion Control.

Table XV (Continued)

Quadrangle	"S	"W	Number	Type	Purpose	Area Serviced	CC SYL*	RM Jus'f'n @ $2.50 per SYL per Ann.	Other Justification	Est.Cost	Type of Work Recommended
111°30' 36°30'	16-3/4	7-1/2	3A-170	Maintenance	Stock Distribution	10,000	000	$ 3,000.00	$	$ 70.00	Widen spillway.
111°30' 36°45'	5-1/8	8-1/8	3A-188	"	" "	7,000	50	126.00		50.00	Repair pipeline.
111°15' 36°30'	11-3/4	4-1/4	3A-194	"	" "	7,000	112	280.00		No. est.	Replace pump handle.
111°15' 36°15'	2	8-1/4	3A-201	"	" "	5,000	20	50.00		" "	" " "
111°15' 36°30'	15-3/4	9-3/4	3A-209	"	" "	7,000	56	140.00		" "	Replace pump handle and diaphram.
111°15' 36°15'	1-1/4	6	3A-210	"	" "	7,000	84	210.00		" "	Replace diaphram.
111°30' 36°00'	13-1/2	9-1/2	3A-71	Development.	" "	5,000	280	700.00		475.00	Raise dam. Install partial diversion.
111°30' 35°45'	1/4	10	3A-70	"	" "	8,000	480	1,200.00		450.00	Raise dam 5'.
111°30' 35°45'	5	6-1/2	3A-259	New Project	" "	10,000	580	1,450.00	800.00 EC	4,100.00	Construct Reservoir.
111°30' 35°45'	2	11-1/2	3A-258	" "	" "	10,000	300	750.00	100.00 EC	1,750.00	" "
111°30' 36°15'	6	13-3/4	3A-257	" "	" "	7,000	420	1,050.00	100.00 EC	1,500.00	" "
111°00' 36°15'	15	4	3 A-253	" "	" "	10,000	560	1,400.00		5,000.00	Drill well if geologically soumd.
111°30' 36°15'	7	5	3A-255	" "	" "	5,000	120	300.00	100.00 EC	1,500.00	Construct Reservoir.
111°30' 36°15'	12-1/4	4-1/2	3A-256	" "	" "	7,000	112	280.00	100.00 EC	1,500.00	" "
111°30' 35°45'	5-1/2	3-1/2	3A-260	" "	" "	5,000	140	350.00	100.00 EC	1,000.00	" "
111°45' 36°30'	4-1/2	3-1/2	3A-261	" "	" "	10,000	600	1,500.00		5,200.00	" "
111°15' 36°00'	9	9-3/4	3A-59	Maintenance	Water During Dipping Time			100.00		15.00	Repair bursted pipe.
111°00' 36°15'	17	1-1/2	3A-148	Development	Erosion Control	4,000	160	400.00	150.00 EC	150.00	Fence desilting plot.
111°00' 36°00'	15-1/2	5	3A-152	"	Stock Distribution.	5,000	120	300.00		470.00	Develop spring.
111°30' 36°00'	8-1/2	7-1/4	3A-76	Maintenance	" "	7,000	336	840.00	50.00 EC	75.00	Repair desilting plot fence.

Table XV (Continued)

Quadrangle	"S	"W	Number	Type	Purpose	Area Serviced	CC SYL*	RM Jus'f'n @ $2.50 per SYL per Ann.	Other Justification	Est.Cost	Type of Work Recommended
111°30' 36°00'	9-1/4	10-1/2	3A-75	Maintenance	Stock Distribution	7,000	280	$ 700.00	$	$ 125.00	Widen spillway
111°30' 36°00'	12	11-1/4	3A-72	Maintenance & Development	" "	5,000	240	600.00	150.00EC	525.00	Widen spillway. Fence desilting plot.
111°00' 35°45'	7-1/2	11-1/4	3A-34	Development	" "	7,000	56	140.00		320.00	Develop spring.
111°30' 36°00'	1-1/4	8-1/4	3A-54	"	" "	5,000	80	200.00		325.00	Raise dam, provide spillway.
111°30' 36°15'	16-1/4	8-1/4	3A-53	Maintenance	" "	5,000	80	200.00		325.00	Clean reservoir, raise dam.
111°15' 35°45'	5-1/4	2-3/4	3A-35	"	" "	7,000	140	350.00	50.00EC	470.00	Develop spring.
111°30' 35°45'	2	6-1/4	3A-66	Maintenance & Development	Erosion Control	5,000	160	400.00	50.00EC	350.00	Fence desilting plot.
111°45' 36°30'	12-1/4	3-1/2	3A-174	Development	" "	10,000	720.	1,800.00	150.00EC	300.00	" " "
111°45' 36°30'	10-1/4	4-3/4	3A-175	"	" "	10,000	720	1,800.00	150.00EC	300.00	" " "
111°45' 36°30'	7-1/2	1-1/2	3A-176	Maintenance & Development	" "	7,000	336	840.00	150.00EC	450.00	" " "
111°30' 36°30'	7-3/4	7-1/2	3A-177	Development	" "	5,000	280	700.00	50.00EC	575.00	Raise dam,fence desilting plot.
111°15' 36°30'	16-5/8	1-5/8	3A-197	"	Stock Distribution	7,000	56	140.00		355.00	Develop well with hand pump.
111°15' 36°30'	11-1/2	5-1/2	3A-193	"	" "	10,000	200	500.00		895.00	Windmill & storage tank.
111°00' 36°00'	15-1/2	12-3/4	3A-30	Maintenance	" "	10,000	40	100.00		75.00	Repair cribbing.
111°00' 35°45'	3-1/2	10	3A-32	"	" "	10,000	45	115.00		150.00	Repair pipeline and divert water.
111°30' 36°30'	14-1/2	9	3A-173	Development	Erosion control	5,000	280	700.00	50.00ED	450.00	Fence desilting plot.
111°30' 36°30'	3	8-3/4	3A-160	Maintenance & Development	" "	10,000	440	1,100.00	50.00EC	475.00	Raise dam. Fence desilting plot.
111°30' 36°30'	12-1/4	1/4	3A-161	"	" "	5,000	80	200.00	50.00EC-	575.00	Clean reservoir. Fence desilting plot.

Table XV (Concluded)

Quadrangle	"S	"W	Number	Type	Purpose	Area Serviced	CC SYL*	RH Jus'f'n @ $2.50 per SYL per Ann.	Other Justification	Est.Cost	Type of Work Recommended
111°30' 36°00'	0	2-3/4	3A-55	Development	Erosion Control	10,000	120	$ 300.00	$ 50.00EC	$ 300.00	Fence desilting plot.
111°00' 36°15'	10-3/4	8-1/2	3A-16	Maintenance	Stock Distribution	5,000	80	200.00		10.00	Clean out around trough.
111°30' 35°45'	0	2-3/4	3A-65	Maintenance	" "	3,000	72	180.00		250.00	Repair diversion ditch.
111°00' 36°15'	7-1/2	6-1/2	3A-144	"	" "	2,000	32	80.00		25.00	Repair trough.
111°30' 36°00'	15-1/8	2	3A-64	Development	" "	3,000	48	120.00		450.00	Clean reservoir, raise dam
111°30' 36°00'	9	6	3A-77	Maintenance	" "	7,000	420	1,050.00		250.00	Raise dam.
111°30' 35°45'	5-3/8	12	3A-69	M "	" "	8,000	320	800.00		1,000.00	Clean reservoir.
111°30' 35°45'	3-1/8	5-3/4	3A-67	Maintenance & Development.	" "	7,000	112	280.00		100.00	" "
111°00' 35°45'	4-1/2	6	3A-155	"	" "	5,000	80	200.00		60.00	Clean well. Install pump.
111°00' 36°15'	6-3/4	13-1/2	3A-18	Maintenance	" "	1,500	24	60.00		50.00	Repair pipeline. Clean spring.
					Total - -	464,500	15,678	$36,226.00	$2,790.00	$52,239.50	

Table XVI — Range Rodent Control (Listed in Order of Priority)

Type	Surface Acres	Dens per Acre (PD)	Approx. F. A.	CC-SYL	Estimated Cost
		IMMEDIATE CONSIDERATION			
G-31	66,000	3	9,000	3,960	$9,900.00
G-1 & G-2	18,000	1	2,160	864	1,450.00
		ULTIMATE CONSIDERATION			
G-23 & G-22	25,000	1.0	4,000	16,000	
G-24	4,500	1.5	540	216	
G-30	22,500	1.0	2,700	1,080	
	52,000				$7,800.00

Rodent Control on Farmland

Area	Surface Acres	Estimated Cost
	IMMEDIATE CONSIDERATION	
Cedar Ridge-Cap Area	1,600	
Coal Mine Mesa Area	750	
	2,350	$350.00

Total all Control - - - - - - - - - - 138,350 Surface Acres
$19,500.00 Estimated Cost

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Table XVII Water Spreading Projects

Location	Number	Acres Range	Acres Farm	Estimated Cost
111°15' 36°00'	EC#1	200		$200.00
111°15' 36°15'	EC#1	800		400.00
	Total -	1,000		$600.00

Erosion Control Projects on Range.

Location	Number	Acres Range	Acres Farm	Estimated Cost
111°15' 36°15'	EC#1	750	10	$740.00
111°30' 35°45'	EC#1	800		270.00
111°30' 36°00'	EC#1	500		150.00
	Total -	2,050	10	$1,150.00

B. FARM DEVELOPMENT:

1. Subjugation:

Projects for development on present and potential farmland, including type of work recommended and cost per acre, are to be found in Table IX of this report, including subjugation and farms on which a change in cultural practices is recommended. In the justification of farm developments in the area, it must be borne in mind the decided lack of farm resources of the Unit. It is felt more money could be spent in the area than on similar projects elsewhere on the Reservation.

Rodent control projects are covered in Table XVI.

In addition to projects covered by Table IX of this report there are certain projects covered by engineering projects on farmland. A list of these follows:

Table XVIII Engineering Projects on Farmland

Location	Type of Work	Priority P*	Priority S*	Acreage	Estimated Cost
Upper Moencopi	Ditch change	X		780	$ 150.00
Dam	Erosion Control	X		780	2,400.00
	Flood Control	X		780	100.00
Lower Moencopi Diversion	Diversion	X		400	500.00
Moenave D. A.	Storage A	X			1,050.00
	" B	X			250.00
Farm #9	Flood Cont.	X			110.00
Farm #10.1	" "	X			350.00
Farm #11	Storage	X			450.00
Farm #12	Erosion Control	X			200.00
Navajo Springs.	No estimate until a determination of whether there is enough water to warrant development.				

*P - Primary
S- Secondary

C. PLANTING:

Table XIX Areas Recommended for Planting

Location	Purpose	Plan	Species
Farms.	Windbreak.	L-479	Cottonwood, Russian olive, Rhus, Chamisa, etc.
Hopi Reservoir.	Wildlife.	L-350	
Desilting Plots. at 3A-63,-75, -76,-165,-167, -170,-178,-191, and at 3A-55, -66,-72,-160, -161,-173,-174, -175,-176, and -177 when completed.	Erosion Control. Water Conservation, Desilting, Wildlife.	L-478	Chamisa, sacaton, Galleta, Rhus,etc.
Moencopi Drainage.	Erosion control.	L-470	Cottonwood, willow, Tamarisk, etc.
6 miles above Cameron.	Woodlot.		Cottonwood, tamarisk.