

NAVAJO SERVICE
LAND MANAGEMENT SURVEY
UNIT - 2
ENGINEERING REPORT

1950 28.

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NAVAJO SERVICE

LAND MANAGEMENT UNIT NO.2

Engineering Report

C. L. Moyes
Engineering Aide

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Location and Boundary:

Land Management Unit Number Two is located in the northwestern portion of the Navajo Reservation. One-fourth of the Unit is in San Juan County, Utah and the remainder is about equally divided between Navajo and Coconino Counties, Arizona. It lies approximately between $36^{\circ}15'$ and $37^{\circ}15'$ north latitude and between $110^{\circ}30'$ and $111^{\circ}15'$ west longitude.

Beginning at the junction of Navajo Canyon and the Colorado River and proceeding clockwise the boundary of the Unit is as follows: It runs up the Colorado and San Juan Rivers, which also form the reservation boundary, for a distance of about fifty miles in a northeastern direction; it then goes southward following the eastern edge of No Man's Mesa, the western edge of the Segi Canyon and a small drainage on Black Mesa, for a distance of about fifty-five miles to the Moencopi Wash; it then runs southwest down this wash for a distance of seventeen miles where it turns north, following a drainage divide ten miles to a high point on the rim of Black Mesa; from here it goes northwest for fifteen miles to White Mesa, then northward for fifteen miles along the eastern edge of this mesa and into Navajo Canyon; it then goes westward for thirty-five miles along the south rim of Navajo Canyon to the Colorado River, the point of origin.

The boundary, as outlined above, encloses an area of 1,094,976 acres. Included in this are the following figures:

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Inaccessible and barren -----	370,000	acres
Waste -----		acres
Mountainous -----	300,000	acres

Roads and Trails:

The roads of Unit #2 have been given two classifications. Graded dirt roads are those which have been bladed and are maintained at more or less regular intervals. Unimproved roads are those which are passable to cars but are not maintained. There are no improved roads either on the Unit or close to it.

The following roads are classed as graded dirt roads:

The Tuba City-Hayenta road. This road passes from east to west through the southern part of the Unit. The road is maintained more than any other road in the Unit; however, it is impassable during rains and is rough at all times.

The Cow Springs-Shonto road. This road is maintained occasionally and is passable except during hard rains.

The Red Lake (Tonalsa) - Inscription House - Navajo Mountain Road. This road is maintained occasionally between Red Lake and Inscription House. The part from Inscription House to Navajo Mountain is very seldom maintained and is quite rough at all times. The road is impassable during storms.

There are five truck trails classed as graded dirt roads

on the Unit. The one up Black Mesa to the Kayenta Coal Mine is maintained frequently and is in good shape except during storms. The road may be closed by snow during the winter months. The road over Black Mesa, east of Cow Springs, is given little maintenance. The road is hard to get over at any time and may be impassable even during light storms. The truck trail from Inscription House to Kaibito is maintained infrequently and is quite rough. It may be impassable after any storm. The truck trail to Piute Mesa apparently has had no maintenance since its construction. It is quite rough and has washed out in several places where it crosses the Piute Canyon drainages. The road is passable for wagons but not for cars. The roads into Be-Ta-Ta-Kin Ruin from Shonto and from the Tuba City to the Kayenta road is maintained occasionally. The road is rough but passable at all times.

Unimproved roads are to be found in the southern portion of the Unit, from Black Mesa on the south to Inscription House on the north. This portion of the Unit is accessible to cars except during storms. There are a few unimproved roads on the Rainbow Mesa southeast of Navajo Mountain. These roads are rough but passable most of the time.

The area north and west of Navajo Mountain has no roads of any kind in it. Several stock trails are to be found in this area. Stock trails are also found into Navajo Canyon,

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Flute Canyon, Navajo Mountain, Nakai Canyon, and Black Mesa.

Telephones:

Telephones within this Unit are located at Shonto, Inscription House and Navajo Mountain. All of these are connected with the Tuba City to Kayenta line, and are handled through the Tuba City exchange.

Trading Posts:

The three trading posts within this Unit are Inscription House, Navajo Mountain (Dunn's) and Shonto. The Rainbow Lodge is run as a dude ranch and does no trading with the Navajos. There are two trading posts located just west of the Unit boundary, Cow Springs and Kaibito.

National Monuments:

The Rainbow Bridge National Monument lies in the northwestern portion of the Unit. It can be reached by a fourteen mile pack trip from the Rainbow Lodge.

The Inscription House Ruin National Monument lies in the Navajo Canyon about four miles northwest of the Inscription House Trading Post. It can be reached by a three mile walk or pack trip.

The Be-Ta-Ta-Kin Ruin National Monument lies just outside of the eastern boundary of Unit #1. It can be reached

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by a one-mile walk from the top of the Segi Canyon.

Schools and Hospitals:

The only schools on Unit #2 are the day schools at Navajo Mountain and Shonto. There are no hospitals in the Unit; however, there is one at Tuba City which is thirty-five miles east of the boundary.

Population:

The population of Unit #2 is approximately 915 or 116 consumption groups. The areas of population concentration are Piute Canyon, Navajo Canyon and Klethla Valley.

Climatological Data:

As no climatological records have been kept on this Unit, it is necessary to use the data at Lee's Ferry, Tuba City and Kayenta. The records of Kayenta will probably be more applicable to this area than those of Tuba City and Lee's Ferry.

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AVERAGE ANNUAL PRECIPITATION

Station	Period of Records	J	F	M	A	M	J	J	A	S	O	N	D	Ave. Ann. Pop'n	Dt. 1st. Klg.	Dt. 1st. Klg. Frst. Frct.
Kayenta	1915-1930	.03	.43	.64	.42	.36	.39	1.45	1.59	.75	.91	.64	.61	8.80	163	6/1 9/21
Tuba City	1897-1930	.55	.54	.54	.43	.53	.19	.34	.93	.34	.69	.78	.58	6.92	179	5/19 9/19
Lee's Ferry	1916-1930	.34	.60	.44	.59	.26	.16	.76	.96	.59	.64	.42	.44	6.20	229	4/18 10/18

TEMPERATURE RECORDS

Station	Record of	Period	J	F	M	A	M	J	J	A	S	O	N	D	Year
Kayenta	Mean	1915-1930	27.8	37.5	44.2	51.8	61.2	70.5	76.1	73.2	65.9	54.0	40.7	30.0	52.7
Kayenta	Absolute Maximum	"	"	"	"	"	"	"	"	"	"	"	"	"	104
Kayenta	Absolute Minimum	"	"	"	"	"	"	"	"	"	"	"	"	"	-15
Tuba City	Mean	1898-1930	32.0	39.2	45.9	53.8	61.7	71.1	76.8	77.8	67.8	55.7	43.4	32.3	54.8
Tuba City	Absolute Maximum	"	68	75	85	88	99	104	105	108	100	88	70	108	
Tuba City	Absolute Minimum	"	-15	-3	12	14	22	34	40	44	28	18	8	-13	-15
Lee's Ferry	Mean	1916-1930	34.8	43.9	52.9	61.1	70.5	80.2	86.3	75.7	75.8	62.3	47.2	36.4	61.3
Lee's Ferry	Absolute Maximum	"	"	"	"	"	"	"	"	"	"	"	"	"	114
Lee's Ferry	Absolute Minimum	"	"	"	"	"	"	"	"	"	"	"	"	"	5

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AVERAGE ANNUAL PRECIPITATION

Station	Period of Records	J	F	M	A	M	J	J	A	S	O	N	D	Avg. Ann. Pcp'n	Avg. Lgth. of Grig. Season	Dt. 1st Klg. Frost	
		.63	.43	.64	.42	.36	.39	1.46	1.58	.75	.91	.64	.61	8.80	163	6/1	9/21
Kayenta	1915-1930	.55	.54	.54	.43	.53	.19	.34	.93	.84	.68	.78	.58	6.92	179	5/19	9/19
Tuba City	1897-1930	.34	.60	.44	.59	.26	.16	.76	.96	.59	.64	.42	.44	6.20	229	4/13	10/18

TEMPERATURE RECORDS

Station	Record	Period of Records												Year	
		1915-1930	J	F	M	A	M	J	J	A	S	O	N		D
Kayenta	Mean	27.6	37.5	44.2	51.8	61.2	70.5	76.1	78.2	65.9	54.0	40.7	30.0	52.7	104
Kayenta	Absolute Maximum	"	"	"	"	"	"	"	"	"	"	"	"	"	-15
Kayenta	Absolute Minimum	"	"	"	"	"	"	"	"	"	"	"	"	"	-15
Tuba City	Mean	1898-1930	32.0	39.2	45.9	53.8	61.7	71.1	76.8	77.8	67.8	55.7	43.4	32.3	54.8
Tuba City	Absolute Maximum	"	66	73	85	88	99	104	105	108	100	95	88	70	106
Tuba City	Absolute Minimum	"	-15	-3	12	14	22	34	40	44	28	18	8	-13	-15
Lee's Ferry	Mean	1916-1930	34.8	43.9	52.9	61.1	70.5	80.2	86.9	73.7	75.8	62.3	47.2	36.4	51.3
Lee's Ferry	Absolute Maximum	"	"	"	"	"	"	"	"	"	"	"	"	"	114
Lee's Ferry	Absolute Minimum	"	"	"	"	"	"	"	"	"	"	"	"	"	8

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AVERAGE EVAPORATION IN INCHES

1921-1930

Station	J	F	M	A	M	J	J	A	S	O	N	D	AVG. Ann.
Lee's Ferry	2.076	3.088	5.773	7.967	11.594	12.773	13.359	11.083	8.917	6.113	2.945	1.928	87.615

AVERAGE WIND MOVEMENT IN MILES

1921-1930

Station	J	F	M	A	M	J	J	A	S	O	N	D	AVG. Ann.
Lee's Ferry	1,068	1,216	1,975	1,889	1,940	1,737	1,570	1,392	1,267	1,323	1,057	963	17,278

From a study of these records the following figures can be applied to Unit #2:

Average yearly precipitation - - - - - 8.5 inches

Average yearly precipitation (Black Mesa) -10-12 "

Average yearly precipitation (Navajo Mt.) 10-12 "

Length of growing season - - - - - 150-160 days

Length of growing season (Navajo
and Piute Canyons) - - - - - 165-170 "

The length of the growing season will be considerably shorter than the above figures on Black Mesa and Navajo Mountain. However, there is no agriculture of any importance in these places.

Drainage and Runoff:

About two-thirds of the Unit drains northward into the Colorado and San Juan Rivers. Runoff from this area will be high, due to the large areas of exposed sandstone, steep slopes along the sides of deep canyons, and the lack of a protective vegetative cover. Flood runoff in this area has not been calculated except at the points where projects are located. Generally no use can be made of the flood water as the quantity cannot be handled on the small area which would be available for water spreading. Small permanent streams in both Navajo and Piute Canyons are used for irrigation at the present time. A small permanent flow in Nakai Canyon has been used on about

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ten acres of land; however, no use has been made of it for the last few years.

About one-fourth of the central portion of the Unit drains to the southwest through Klethla Valley into Cow Springs Lake. Runoff from this area will be low with the exception of localized areas of steep slopes and exposed sandstone. Cow Springs Wash and a small area along the steep slopes of Black Mesa provide the larger portion of the runoff into Klethla Valley and Cow Springs Lake. There is also a permanent flow of one second foot from Cow Springs Wash into the lake. All of the flow of Shonto Wash is held within the boundary of Unit Number Two since the reservoir marked on the map as 2A-2 will hold considerably more water than is expected to flow into it. A permanent flow of approximately three-quarters of a second foot is used for irrigation purposes at Shonto. No agronomic use can be made of the drainages on Black Mesa, which flow southward into the Moencopi Wash. The runoff from this portion of the mesa is high; however, no calculations have been made of the flood expectancy of the drainages.

The drainages of this Unit were numbered on the Agronomy and Engineering map using the same system applied to all Units of the Navajo Reservation. The following numbers were given to the main drainages of Unit #2.

Colorado River	#1.0
San Juan River	#2.0
Navajo Canyon	#3.0
Piute Canyon	#4.0
Cow Springs (Begishibito) Canyon	#5.0
Shonto Wash	#6.0
Klethla Valley	#7.0
Moenopi Wash	#3.0

Lesser side drainages of these are given the whole number of the main drainage, with a decimal to indicate which side it enters from. For example: Facing upstream on Cow Springs Canyon at the Unit boundary line the first wash to the left is #5.1, and the second to the left #5.3. Those entering from the right are given consecutive even decimals.

The annual runoff has been estimated only at those locations where it is possible to use the water for agricultural purposes or where erosion control projects are recommended. These figures will be found in the discussion of the individual projects and in the following table:

Location	Water Supply			Area to be Benefitted		
	Ann. Expec- tancy	Max. Expec- tancy	Max. Expec- tancy	Acres Pres. Emd.	Acres Pot. Emd.	Acres Range
	A/ft	Sec/ft	A/ft			
<u>Quad 110°45' x 36°45'</u>						
Wash # 5.3 At EC#1	60	1000	250			2500
Wash # 5.3" EC#2				1.5	5	5
At Farm #21	75	800	200	25		500
<u>Quad 110°30' x 36°45'</u>						
Wash # 6.0 At Shonto	200	2000	500	20	20	50
Wash # 7.0 At EC#2	250	2000	500	35	5	2000
Wash # 7.14" EC#3	20	500	125			1000
<u>Quad 110°30' x 36°30'</u>						
At Farms #4, 5 & 5.1						
	60	800	200	30		
At Farm #14	60	750	150	12	10	
<u>Quad 110°30' x 37°00'</u>						
Wash # 2.12 At EC#1	75	1000	250		25	1000
<u>Quad 110°30' x 37°15'</u>						
Wash # 2.10 At EC#1	125	1800	450	45	25	3000

Topography:

Elevations of Unit #2 range from 3200 feet at the junction of the Colorado River and Navajo Canyon to 10,250 feet on Navajo Mountain.

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The following elevations have been taken from the U. S. G. S. topographical maps edited in 1891 and 1892:

Average elevation	-----	6,000 feet
Navajo Mountain	-----	10,250 "
Black Mesa	-----	7,200 "
Inscription House T. P.	-----	6,600 "
Shonto	-----	6,200 "
Rainbow Lodge	-----	6,000 "
Navajo Mountain T. P. (Dunn's)	-----	6,000 "
Klethla Valley	-----	5,800 "
Lower end of Mooncopi Wash	-----	5,400 "
Nakai Canyon	-----	5,000 "
Piute Canyon	-----	5,000 "
Navajo Canyon	-----	4,600 "
Junction of Colorado & San Juan Rivers		3,500 "
Lower end of Colorado River	-----	3,200 "

The topography of the northern two-thirds of Unit #2 is characterized by high mesas between large deep canyons and by Navajo Mountain. The canyons are from 1500 to 2000 feet deep with steep side walls and a relatively level narrow bottom. Navajo Mountain stands 4500 feet above the high mesa between Navajo and Piute Canyons. The central portion of the Unit is a gently sloping plateau bordered by White Mesa on the west and Segi Canyon on the east. This area is cut by two small

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canyons, Cow Springs Canyon and Shonto Canyon. The southern portion of the Unit lies on Black Mesa where the topography is very rough and is characterized by high vertical cliffs and deep canyons.

Soils:

The majority of the soils of the Unit originate from sandstone. Thus the inherent characteristics of the soils account for large potential wind erosion areas, especially when the plant cover has been depleted.

The greater portion of the soils originate from the greyish white to pink Navajo sandstone. This sandstone, composed of medium sized rounded quartz grains, loosely cemented with calcium carbonate, originates the coarse textured, easily wind blown Floy, Todilto and Kayenta series.

Thin beds of greenish gray sandy limestone on the foot slopes of Navajo Mountain give rise to the gravelly, highly calcareous Rainbow series. The heavier textured Concho series develop on alluvium from the Mancos shale of Black Mesa and is severely affected by water erosion. The Demehotse and Tolani series, highly susceptible to wind erosion, develop on the alluvium from the Navajo sandstone. Those undifferentiated soils developed from Mancos shales on Black Mesa are easily eroded when the plant cover is disturbed.

Residual soils occupy the greater portion of the area. They constitute the better classes of grazing land. The Floy and Todilto series are most important of the five residual series surveyed.

Of the six alluvial series mapped, portions of the Concho, Dennehotso and Tolani are important agronomically.

Erosion:

The west and north portions of Land Management Unit #2, with the lone dominating peak of Navajo Mountain in the extreme north, presents an indescribable area of normal geologic erosion. High, rounded, closely-spaced domes and deep narrow canyons create an impression of a barren billowy waste - one of remarkable scenic grandeur. Here normal erosional forces, unaided by man, are seen at their best.

The central and southern portions of the Unit, with their soil and vegetative cover accessible to man and livestock, are susceptible to accelerated erosion. However, erosion in this vicinity is slight at present.

Low annual rainfall and light textured soils, in conjunction with moderate to severe over-utilization of the vegetative cover, have resulted in a predominance of wind erosion north and east of Navajo Mountain and along the north side of Kletkha Valley. Partially stabilized sand dunes are

common to both these areas. The entire Unit is susceptible to wind erosion; however, it is not severely wind blown except in localized areas.

The heavy soils of Kletthla Valley, their vegetative cover severely over-utilized and depleted, are ravaged by the consequent rapid runoff. Sheet and gully erosion is severe in this area.

Steep slopes and an inadequate vegetative cover have accelerated the erosion on Black Mesa. The resultant increase in runoff from here is causing considerable damage in Kletthla Valley.

Innumerable short drainages, throughout the Unit, are rendered valueless by gullies. Gully heads are gradually extending into valuable land in the vicinity of Inscription House.

Vegetation:

(a) Zones: Vegetation of the Unit varies from that typical of the Upper Sonoran to that typical of the Transition Zone. The entire area, with the exception of Navajo Mountain, falls in the former class and is typified by woodland, sage brush, or browse. Navajo Mountain, an area of approximately 10,500 acres, is typified by Ponderosa pine, Limber pine, aspen, spruce and Douglas fir.

(b) Vegetative Species; The following is a list of species typical of the area. An attempt was made to list the species in the order of importance from an economic standpoint rather than value as range forage or abundance:

Forage Species - Blue Grama

Big Sage
Black Brush
Snakeweed
Yellow brush
Grilleta Grass
Greasewood

Woodland Species - Pinon

Juniper
Oak
Ponderosa Pine
Douglas fir

Agriculture:

This Unit cannot be classed as one which is favorably adapted to agriculture because of the lack of sufficient water supplies for producing crops.

With the exception of four small agricultural concentrations, the farming acreage is made up of small scattered farms usually located on gully fans. The four concentrations noted

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