NAVAJO SERVICE

LAND MANAGEMENT UNIT 8

ENGINEERING REPORT

JUNE - SEPTEMBER, 1936

Submitted by

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Asst. Agri. Engr.

2nd Edition

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NAVAJO SERVICE
LAND MANAGEMENT UNIT 8
ENGINEERING

DRAINAGE

For purposes of description and analysis the main drainages in Unit 8 have been selected and numbered.

Six drainages were numbered in the following order: San Juan River, Chinlee Wash, Laguna Creek, Tyende Wash, Moonlight Wash, and Gypsum Creek.

No apparent use can be made of San Juan River or Chinlee Wash waters. San Juan River flows in a narrow deep gorge almost its entire length along the boundary. Chinlee Wash is confined in a narrow valley from one fourth to one half mile wide for its entire length along Unit 8. It has cut a channel from 300 to 600 feet wide having vertical banks 15 to 30 feet high. If a diversion were feasible and economical the probable quantity of runoff carried by this wash, together with the limited area of land adjacent for water spreading, would make such a proposal unsound.

Laguna Creek, a perennial stream, is used for irrigation purposes. Its flow decreases to less than a cubic foot per second during the early summer.

Diversions for irrigation purposes are made from Laguna Creek at Kayenta and at Dennehotso. With the exceptions of the locations at Kayenta and Dennehotso where the diversions are made, the stream flows in a gully 100 feet to 300 feet wide and 20 feet to 100 feet deep with vertical banks.

Moonlight Wash also has a permanent supply of water for part of its length. Water is diverted from Moonlight for irrigation. Approximately ten miles from its mouth at San Juan River, Moonlight Wash enters a narrow rocky gorge.

Gypsum Creek, while classed as a perennial stream, does not furnish water in quantities sufficient for irrigation use. Its waters are used for livestock watering only. Near the head of the stream no land is available for farming and by the time the wash is followed downstream to where land is available the water has disappeared into the sands.

Tyende Wash is an intermittent stream. However, it is the drainage for a large area and during the rainy season often carries large quantities of runoff heavily laden with silt.

All of the drainages carry large quantities of runoff during the period of summer rainfall. Usually the runoff occurs at large floods of short duration and the waters carry enormous quantities of silt.

AGRICULTURE

Farming is concentrated in three localities; Dennehotso, Kayenta, and to a less extent along Moonlight Wash in Segihotsosi Canyon.

Kayenta Farms Area obtains water for irrigation from Laguna Creek. The Indian Irrigation Service constructed a rock masonry diversion weir across Laguna Creek and the winter flow of clear water is diverted into a storage reservoir of 300 acre feet capacity.

The stored water is used in the spring for one irrigation. The farms are then dependent upon rainfall for the balance of the season. No floodwater is diverted. The character of the silt carried by the floods is undesirable on the land.

The outlet ditch from the reservoir to the farmlands is in a deep cut and this cut is usually so full of blow sand that water cannot be drained from the reservoir without removal of large quantities of sand from the ditch. The ditch from the diversion dam to the reservoir is also subject to becoming filled with blow sand to such an extent that water cannot be conveyed into the reservoir. In 1935 the reservoir was drained approximately July 10. Only one wetting of the farmlands was accomplished from the reservoir.

With some raising of the embankment at the lower end of the reservoir and raising the diversion weir and headworks, additional storage can be obtained in the reservoir. By raising the water surface in the reservoir two and one-half feet an additional 500 acre feet in capacity can be realized and only thirty-five acres in exposed surface will be added to the present area of two hundred acres.

There are, in 1936, approximately 400 acres under cultivation at Kayenta.

The Indian Irrigation Service has constructed a rock masonry weir type diversion on Laguna Creek at Dennehotso. This is a direct diversion. There are approximately 700 acres that have been cultivated at Dennehotso. An additional 100 acres of farmland are

available. Under the present conditions and with the present water supply this total amount of land cannot be irrigated.

The division of the water from Laguna Creek between Kayenta and Dennehotso is as follows:

Dennehotso, by continual use of the water from Laguna Creek, has a recognized water right dating back to 1924.

Each spring, however, leaders from Kayenta and Dennehotso meet and make a verbal agreement concerning the division of water. It has been customary that Dennehotso receives the entire flow for two months beginning April 1, then for alternate 15 day periods throughout the growing season. Kayenta has the right to the flow from September 1 to April 1, which is supposed to be stored in the reservoir.

There are approximately 30 acres in scattered farms cultivated on Moonlight Wash at the lower end of Segihotsosi Canyon. There are approximately 30 acres of land in the same vicinity that can be subjugated.

There is a steady flow in the canyon. In May, 1936 this flow was estimated one half second foot. This quantity increases after the summer rains begin. On July 21, 1936 an estimated one second foot of clear water was flowing.

The Indians use small earth embankments thrown across the stream to divert the flow into their ditches. The diversions wash out with every flood and have to be rebuilt.

The Indian Irrigation Service completed a rock masonry weir type diversion dam on this wash in 1932. An outlet was provided but a conveyance ditch was not constructed. This was supposed to be completed by the Indian farmers. No ditch has ever been built.

With the exception of a number of scattered dry farms totaling 80 acres, the balance of present cultivated farms totaling about 450 acres, depend upon floodwater for irrigation. These farms are scattered over the entire unit and vary in size from one-half an acre to twenty-two acres. Most of the farms are two or three acres in size.

The farms are usually located on fans of intermittent washes or at the foot of bare sandstone slopes. Those located on the fans are usually covered with overwash consisting of sand and large rock, and in some cases, clay. They are, as a general rule, very rough and uneven as regards surface. Poor distribution of water is achieved. Only the larger floods which completely inundate the fields assure a complete wetting. Stands are very spotted as a result.

The farms at the base of sandstone slopes are usually in a light soil which is very susceptible to wind erosion and they soon blow out or other sand blows in and they are difficult to water because their surface is so uneven or so much sand lays between the foot of the slopes and the fields that only runoff from capitol storms reaches the farms.

WATER SPREADING

There are a large number of sites that offer possibilities

for diversion and spreading of floodwaters that have concentrated in the larger drainages.

Water spreading sites selected by the water spreading survey were inspected. Some of the locations were rejected as to feasibility and from an economical viewpoint.

Additional water spreading possibilities were located.

Water spreading areas as indicated on the original survey were almost without exception located low down on the drainages where large quantities of floodwater could be expected. The washes carry large percentages of clay and silt with the consequent danger of covering up crops and vegetation if the large quantities are spread on farms and range.

It is desirable that wherever a location is found high up on a drainage that can possibly be used for water spreading purposes that it be done. It is important that wherever possible runoff be kept from accumulating in gullies and eventually reach the larger main washes which are so difficult to handle with diversions.

EROSION CONTROL

Active head erosion is taking place on the irrigated lands as well as generally over the unit.

On Black Mesa head erosion is active in many of the small grassland valleys. The gullies quickly drain off whatever rainfall occurs and are continually progressing up the valleys destroying valuable range.

In the portion of the unit south of Comb Ridge gully erosion is bad. This country consists of large valleys running from the

bottom of the slope of Black Mesa toward Chinlee Wash and toward Laguna Creek. Each of the valleys is cut through by at least one gully. Some are in the early stages of cutting and could be easily halted. Others are very large and have side gullies entering them.

Runoff enters the gullies and is carried quickly out of the country without being of any use. Much good can be done in keeping as much runoff as possible from entering the small drainages.

North of Comb Ridge the terrain is more sloping with short drainages entering the main drainage channels.

The topography is quite steep and when runoff enters the main drainages it is lost to any use. There are many small gullies and trails that are eroding and approaching sizes which will soon be too large to handle under the condition of limited areas upon which to divert water. The valley south of Chaistla Butte contains active cutting gullies that need such treatment as diverting runoff around the cutting heads.

ENGINEERING REPORT ON SURVEY OF DENEHOTSO
COMMUNITY AREA

Denehotso Farms

Description

Denehotso is a community area comprised of approximately 125 families totaling probably 600 inhabitants. It is located twenty-seven miles northeast of Kayenta, Arizona. The Laguna Creek flows through the area and furnishes water for irrigation. The Indians that live in the area generally are from distant localities. They merely move into the vicinity for the spring and growing season to avail themselves of the farming facilities. After the harvesting of the crops in the fall, with the exception of a few families, the inhabitants take their herds and move to their more permanent homes.

The valley proper in which the community is located extends along both sides of Laguna Creek from a point about two miles east of Denehotso, to Kayenta. It varies in width from an eighth of a mile at the lower end to approximately seven miles across the upper portion.

Topography

The valley slopes gently upward from the Laguna toward Comb Ridge on the north and to a low plateau on the south. It follows a course east of northeast and has a fall of approximately twenty-five feet per mile.

The adjacent hills are quite steep and practically denuded of any vegetation. A large percentage (at least 25 %) of the pr pitation is probably lost through runoff.

Beginning at a point five miles above Denehotso Day School the Laguna is thirty feet deep. It is still deepening from the point upstream. For miles the channel is sixty to seventy feet deep with vertical banks that are continually breaking back laterally, contributing enormous quantities of soil and silt to the floods which flow in the Laguna, empty into Chinlee Wash and then are carried to the San Juan River. Laguna Creek serves as an efficient though detrimental drain for practically the whole valley above Denehotso.

From the point five miles west of the day school for a distance of seven miles downstream there are sandstone ledges which have prevented the channel cutting deeper. There are numerous sandstone outcroppings scattered throughout the farmed area in addition to large areas of slick sandstone adjacent to and surrounding a large portion of the farmlands.

Agricultural Lands

The area embracing the farmlands lies on both sides of Laguna Creek. The area is approximately three and two tenths miles long; extending almost equally below and above the day school. It varies in width from one eighth of a mile to one mile. The area above the school contains probably three fifths of the farmed land.

The maximum area that has been under cultivation amounts to 700 acres. Of this amount some land lies idle each year because of insufficient water for the production of a crop.

Potential farmland within the area, were an adequate supply of irrigation water available, amounts to approximately 107 acres. This makes a total of irrigable land within the area amounting to 807 acres. There are approximately 110 acres that can be brought into use but will necessitate lots of land leveling.

Corn is the principal crop. Some alfalfa is raised in small (one-half to four acre plots) patches. A few melons and squash are raised for family use.

Water Supply In 1922 Indians were using an earth dam for diversion cjm. U.S.I.S. completed a log & rock crib dam in March 1924 cjm-c.

The water supply both for domestic and irrigation purposes (excepting the day school and the trading post which have wells) is derived from Laguna Creek.

Six to eight years ago the Indian Irrigation Service constructed a concrete diversion dam across the Laguna and a system of ditches. The cost of the present system was $18,673.00.

This dam permitted the Indians to use the normal flow or any floodwater that they chose to use for irrigation. A year ago the Indian Irrigation Service installed a radial sluice gate at each end of the dam to keep the silt sluiced away from the headworks of their irrigation laterals.

According to information gathered from the Indians they do not divert the mary muddy water from floods caused by summer rains. If the flows happen to be of long enough duration so that the water becomes fairly clear they use the floodwater to irrigate their corn.

A topographic survey was made of a proposed reservoir site located two and one half miles above the present diversion dam. It was proposed to use the reservoir site in conjunction with another possible diversion structure whose site is located three and one half miles above the present dam. (See sheets A and B). A line of levels was run from the reservoir site to the proposed diversion site to obtain relative elevations.

A reconnoissance was made up Laguna Creek for a distance of four miles above the proposed diversion site or to a point nine miles above the Farming District. No additional exposures of sandstone were located. Above the proposed site the channel is cutting deeper. There was no place found where it would be practicable to divert water from the main channel. The banks from the proposed site upstream for four miles are from thirty to seventy feet deep.

An eighteen inch cipolletti weir was set in Laguna Creek approximately 1.25 miles downstream from the present diversion dam in order to obtain a record of the normal flow of water. (See table for quantity).

Observations

The land is generally farmed too close to the edge of the banks of Laguna Creek.

Irrigation ditches in some cases follow along the banks of Laguna Creek too closely. In both cases there is a potential danger of the water getting away from its confines and starting active gully heads. There is also the danger of keeping the

They depend entirely upon the normal flow of clear water for the irrigation of their alfalfa, of which there is approximately 90 acres. The Indians plant their acreage according to whether or not they think there will be sufficient water available to produce a crop.

Conditions being equal it seems that the man living farthest up the ditch has the greatest water rights. The right to the use of the water progresses downstream. If there is water left after the man above uses what he wants, then the next landowner uses whatever portion of the balance he desires, etc.

There are numerous small ditches used that pick up the wastewater and use it on additional land. In this manner there is practically no loss through runoff although it is almost certain a large quantity of water is lost to beneficial use through deep percolation.

There are no available records of streamflow on the Laguna. Some data on the normal flow was obtained in the course of the recent investigations and is given elsewhere in this report.

The Survey

A topographic survey was made of the Agricultural area. The survey includes cultivated land, potential farmland within the area and covers the adjacent lands to the edges of the exposed sandstone. (See Maps 1-7)

vertical banks of the creek saturated with water which causes continual sloughing.

Runoff from the adjacent sandstone hills is causing active gully heads to progress from the creek up through some of the farmland.

There is a site for a diversion dam where the weir setting was made. The banks of the wash are shallow and a ledge of sandstone runs across the entire width of the channel. (See sheet C for section.). A dam at this site, which is approximately one and one quarter miles below the present diversion, would eliminate the necessity of conveying the irrigation water for this distance in an earth ditch with a probable large loss due to absorption. Also a dam would check the waste water that enters the Laguna below the present dam.

If all the flow were diverted at the present dam there would probably be a flow at the proposed lower site of approximately 0.2 second foot. This flow is the result of many small seeps that flow into the creek from the banks. The water enters along the plane of contact between the soil and the underlying sandstone.

There are three acres below this site at present seeded to alfalfa. The clear water saved by a diversion structure at this site could be used in the production of additional alfalfa. The total area of irrigable land below this site is 120 acres.

The Indians do not waste very much irrigation water from runoff since they usually pick the waste water up at the lower end of a field and use it on additional land; however, there seems to be a tendency to use more water than necessary with a resultant loss from deep percolation.

There is apparently some use made of runoff from the sandstone hills to irrigate their crops.

The fields are generally in need of some land leveling to obtain a more uniform spread on the applied water.

The irrigation laterals are in some cases eroding to excessive widths giving a large wetted area, thereby increasing loss of water from absorption. The ditches are in some cases very devious and a rank growth of weeds along the banks adds to the obstruction of the water. The section is generally too small.

Construction of a diversion dam at the proposed site five miles above the day school should be deferred until the existing system is perfected and additional expansion warrants it.

A relatively low structure at this site would accomplish much good as a silt control measure. The grade of the stream is so slight that the effect of a low structure would extend far upstream, still the flow of water and cause a deposition of silt which is carried down in enormous quantities. Such a structure would prolong the greater than normal flow of clear water also.

Plans

1. Preparation of the land under cultivation for irrigation by:

   a. Leveling.
   b. Change of field layout to conform to the topography, i.e., Run the rows with the contour of the land to prevent a fast fall.
   c. Construct substantial borders so that the water can be confined to the area on which it is applied.

2. Improve the existing ditches by:

   a. Change in alignment where possible and where needed.

   b. Constructing new laterals in some cases in order to get a more efficient section. (The new laterals to parallel the present ones.)

   c. Enlarge the irrigation ditches so as to accommodate ditches so as to accommodate larger quantities of water when it is available.

   d. Install rock masonry checks and drops in the laterals to obtain a proper uniform grade and prevent the banks or the bottom from eroding.

   e. Install rock masonry turnouts from the laterals to the principal irrigation ditches in order to provide a better control on the irrigation water.

3. Flood control and protection of the farmland and the irrigation system.

   a. Use of the floodwater from the adjacent sandstone hills for crop production.

   b. Disposal of excessive runoff by spreading it over the land that is in range vegetation.

4. Protection ditches and embankments to keep runoff and waste water from running into the Laguna over unprotected banks. (It is imperative that the Indians shall move at least fifty feet back from the banks of Laguna Creek.)

5. Construction of a diversion dam in Laguna Creek at the lower crossing, one and one quarter miles below the present dam. The structure to be of rock masonry.

6. Development and preparation of potential farmland which can be irrigated from the lower diversion.

Materials:

There is plenty of building rock limestone available within two miles of the day school.

There is a limited quantity of concrete sand of poor quality. It is also difficult to obtain as it occurs in thin layers (12 inches deep) a few inches of dirt covering it.

There is a hill approximately two miles below the day school on which there is a stratum of limestone. Its thickness varies from 18 to 36 inches. A small rock crusher and screening plant would furnish both rock and sand for all concrete necessary.

Woven wire, burlap, and posts would be required for the construction of spreader barriers.

Summary

1. The maximum area that has been under cultivation is approximately 700 acres.
2. There is an additional area of potential farmland of 107 acres.
3. This makes a total irrigable area of 807 acres.
4. There is an additional 110 acres that can be brought into use but necessitating the moving of large quantities of earth. The land is covered with large hummocks.
5. There is at present 90 acres planted to alfalfa.
6. The probable normal flow in the Laguna in September is approximately two second feet.
7. The probable minimum flow at the lower crossing with all water being diverted at the present dam will be approximately 0.2 second feet.

8. Irrigable land below the lower crossing diversion site totals 120 acres. At present only three acres of the 120 are in alfalfa.

9. The use of floodwater is not practiced to a great extent because generally it is too heavily laden with silt.

10. Irrigation ditches and farmed land encroach upon the banks of Laguna Creek.

    There should be 50 feet between the banks and any used land for the purpose of bank protection.

11. A diversion dam at the lower crossing would control an irrigable area of 120 acres.

12. There is a tendency to apply more water to the alfalfa land per irrigation than is needed. The result is the water percolating below the root zone and being lost to beneficial use.

    There should be a system of rotating the water, whereby the farmers would have to use the water when it was in the laterals near their farms.

13. Land leveling is needed to obtain more uniform penetration.

14. The direction of irrigation should be changed in some cases to take advantage of the natural topography, thus, eliminating intensive leveling operations.

15. The cross section of the irrigation laterals should be designed to handle the quantity of water discharged by the outlet gates with a velocity that is not conducive to erosion.

16. The grade in the laterals to be maintained by rock masonry checks and drops.

17. Rock masonry turnouts and distribution boxes to be installed to allow good control of irrigation water.

18. The alignment of the laterals and ditches to be improved to whatever degree that can be agreed upon with the Indians regarding property lines.

19. Some wind protection will be necessary to protect the farmland in the spring and early summer.

20. The construction of a diversion dam at the proposed upper site five miles above the day school be deferred until the present farm land is developed completely and expansion requires such a structure.

WATER MEASUREMENTS IN LAGUNA CREEK OPPOSITE DAY SCHOOL

Date	Time	Head in feet	Length of Crest	3/2 H	Discharge Sec. Ft.	Discharge Gal. Per Min.
Sept. 19	4:55 P.M.	0.0625	1.5'	0.01561	0.07884	35.48
Sept. 20	8:35 A.M.	0.120	1.5	0.0416	0.210	94.5
	12:35 P.M.	0.1275	1.5	0.0455	0.230	103.5
	5:40 P.M.	0.1508	1.5	0.0587	0.2965	135.0
Sept. 21	8:35 A.M.	0.333	1.5	0.1923	0.971	436.5
	12:40 P.M.	0.330	1.5	0.1870	0.944	424.8
	5:40 P.M.	0.314	1.5	0.1760	0.88	400.0
Sept. 22	8:55 A.M.	0.260	1.5	0.1326	0.670	301.5
	12:35 P.M.	0.306	1.5	0.1692	0.855	384.8
	5:10 P.M.	0.187	1.5	0.0809	0.409	184.0
Sept. 23	8:40 A.M.	(No measurement - washed out around weir. Repaired)				
	12:40 P.M.	(Head not attained yet.)				
	4:35 P.M.	0.109	1.5	0.0365	0.184	82.8
Sept. 24	9:10 A.M.	0.162	1.5	0.0653	0.330	148.5
	11:45 A.M	0.167	1.5	0.0684	0.345	155.2
	No measurement					
Sept. 25	8:45 A.M.	0.142	1.5	0.0533	0.270	121.5
	10:45 A.M.	(Rise came down the creek and washed around the weir.)				
Sept. 26	No Measurement; water still high.					
Sept. 27	No. Measurement; water still high.					
Oct. 3	Reset weir at 1:30 P.M.					
	6:40 P.M.	0.3073	1.5	0.1701	0.87	391.5
	9:00 P.M.	0.3125	1.5	0.1743	0.872	392.4
Oct. 4	8:30 A.M.	0.3073	1.5	0.1701	0.87	391.5
	10:00 A.M.	0.3073	1.5	0.1701	0.87	391.5
	2:00 P.M.	0.3073	1.5	0.1701	0.87	391.5
	6:00 P.M.	0.2865	1.5	0.1530	0.77	346.5
Oct. 5	10:00 A.M.	0.2917	1.5	0.1578	0.79	355.5
	4:00 P.M.	.2865	1.5	0.1530	0.77	346.6

Note: When the readings were taken on Oct. 3rd and 4th there was an estimated flood of 1.0 sec.ft. being diverted at the dam and used for irrigation. This would account for a flow of water amounting to approximately 1.9 sec. ft.

The discharges were calculated using the formula: $Q = 3.367\ LH^{3/2}$

ESTIMATE

13 miles of laterals @ $1300. per mile.....	$17,000.00	(Approx.)
800 acres of land leveling @ $15. per acre.....	12,000.00	
4.5 miles of protection dyke along the banks of Laguna Creek @ $1300. per mile.....	6,000.00	(Approx.)
5 miles of flood control ditch with dyke @ $1000.00 per mile.....	5,000.00	
Diversion dam at lower crossing.....	6,300.00	
	$46,300.00	
15% for Engineering and miscellaneous.....	7,300.00	
Total	$53,600.00	
Approximate cost per acre.....	$ 67.00	

T.C. 2869

KAYENTA FARMS AREA

Kayenta Farms area has an inadequate irrigation system. The main irrigation ditch for some of its course follows a suitable grade, then it goes down a slope that is resulting in some cutting. The ditch contains no drops. Excepting a few metal pipe turnouts with a slide gate, no provisions are made for turning water from the ditch onto the farmlands. The fields are not leveled and poor distribution of water is obtained. In some cases the irrigating is done on slopes that permit the water to move so fast that good uniform moisture penetration cannot be obtained.

Work recommended for the Kayenta Farms is as follows:

1. Protect the intake ditch to the reservoir from moving sand until a protective vegetative cover can be obtained on the area just south of the ditch.
2. Lay a pipe in the deep cut from the outlet of the reservoir throughout the length of the present deep cut.
3. Halt the active head erosion within the farms.
4. Alignment of main irrigation ditch to take in all the suitable farmland possible. Relocate all ditches necessary to obtain a good irrigation system.
5. Provide checks and drops in all irrigation ditches to maintain a non-eroding grade.

6. Provide turnouts to the fields.

7. Level and border the fields to be planted in alfalfa.

8. On land that is to be planted to row crops, it is recommended that the furrow method of irrigation be used. This will insure a better usage of the water supply, which is limited. Also it will eliminate the need of extensive leveling operations on the entire farming area, which lays on a slope of 5 to 7 feet per 100 feet. The slope of the land is fairly uniform and advantage could be taken of the topograp[illegible] general contour followed with all rows.

NOTES

1. The findings during the survey with regard to the possibilities of increased storage in the Kayenta reservoir makes it advisable that an investigation be made into the feasibility of raising the present diversion dam or what will be necessary in design and construction to obtain an added height to the reservoir of two and a half feet.

2. Before any large scale development is started on the Oljetoh Farms Project, located on the East branch of Moon Wash, an investigation should be made to determine whether or not there is a sufficient underground flow of water to warrant the necessary expenditures.
Too, the water rights on this stream should be determined.
There is some question as to priority of rights on underflow in (Oljetoh) Moonlight Wash in the vicinity of Oljetoh.
The East branch of Moonlight Wash, on which the development is proposed has the only surface flow.
There is the question of whether the underground flow below Oljetoh has its source from this East branch or comes down Moonlight Wash proper and whether or not any underflow would reach to the point in question below Oljetoh if the underflow in the East branch were cut off and used for irrigation.

T.C. 2872

Note

A one inch to the mile scale map upon which is located all of the proposed jobs is on file.

Maps of both the Danshotso Farms and the Kayenta Farms are also on file and should accompany this report.

SEGIHOTSOSI FARMS

This is a small group of farms, located in the lower end of Segihotsosi Canyon about fifteen miles north of Kayenta. The farms are irrigated, getting their water from Moonlight Wash. There are approximately thirty acres farmed at the present time.

Diversions from Moonlight are made, using small earth embankments thrown up across the Wash. The embankments have to be replaced after each small flood.

The fields are scattered along the banks of Moonlight Wash, and are uneven and poorly prepared for irrigation.

Some of the farms are threatened with erosion from the Wash. Floods are washing away the banks.

The Indians farming in this District have displayed lack of initiative and the desire to improve their farming possibilities.

As mentioned elsewhere in this report, the Indians have never made use of the diversion dam that was constructed across the Wash by the Indian Irrigation Service in 1932. At the time the dam was installed, the Indians agreed to construct the ditch leading from the outlet at the dam to their fields, requiring about one and one-half miles of ditch.

There are approximately thirty additional acres that can be subjugated in the vicinity of the present fields and the water supply is probably adequate to take care of this increase.

To obtain the use of all the available water, however, the ditch should be made and some work done at the dam to insure the water being made available at the ditch and not be lost by overtopping the dam. A small sluiceway in the dam near the outlet to a ditch has never been opened with the result that sand deposits have been made which divert the steady flow away from the outlet and it is at present flowing over the top of the dam. The dam is about four feet high.

To obtain as efficient use of the water as possible, the fields should be leveled and prepared for irrigation. (See cards for proposed work and estimates.)

STORAGE RESERVOIRS IN SLICK ROCK COUNTRY

In Monument Valley and portions of the country in the vicinity of Goulding, there are sites favorable for the construction of small concrete or masonry dams which will create small storage reservoirs. This country contains much bare sandstone rock which supplies a high percentage of runoff. Below some of the sites, small tracts of land, varying in size from two to seven acres, are available for agricultural use, excepting a sufficient water supply to produce crops to maturity. The rainfall in this vicinity occurs in the winter and again in summer. Summer rains usually start late in July and crops have too late a start to mature.

If storage is available, the runoff from the winter rainfall can be stored and used to start a crop in the spring. A crop will have a good start by the time the summer rains start.

Any agricultural land developed in this locality will help a lot, since at present farming is not practiced except in a few instances; most Indians of this vicinity are moving their herds of sheep to Dennehotso while they farm there.

Such development of land and the construction of dams should be done on an experimental basis in order to see if the Indians will take full advantage of such development. (Such projects and their estimated costs are noted on the cards filed.)

FLOODWATER FARMS

The farms that use floodwater irrigation are practically without exception on flood fans of large washes or at the mouth of drainages where, if any runoff occurs, it will sweep over the field or a part of the field.

Poor distribution is obtained under the present method. Most of the fields should be prepared to better utilize the runoff when it occurs.

Work required on the farms consists of bordering to confine the water, or spreading to obtain a more uniform wetting of the fields. Some of the fields need some provision for the control

of the water so that, if desirable, the floods can be diverted around them if the water is not wanted. For each farm the work suggested, together with an estimate of cost, is noted on the file cards.

EROSION CONTROL

Erosion control is generally needed throughout Unit 8. Runoff is large from the Black Mesa and is doing much damage throughout the large valleys, extending from the foot of the mesa toward Laguna Wash and Chinlee Creek.

Water spreading as far upon the heads of the valleys as practical and from the main drainages will help to disperse much of the runoff which is lost to any use and which is contributing to serious erosion.

Other portions of the Unit are subject to water erosion and should be controlled in order to prevent further damage, as well as utilize runoff, which is ordinarily lost to the country where it originates.

Erosion control needs to be done on all roads and trails in the Unit.

Erosion control, water spreading jobs, et cetera, have been outlined on the file cards.

PRECIPITATION DATA

43.5% of the annual rain falls in July, August and September. 68.5% of this will produce runoff. (Considering any rainfall of one-quarter of an inch or over as producing runoff.)

29.8% of the yearly rainfall produces runoff in July, August, and September.

Average rainfall producing runoff in July, August and September - 2.62 inches.

Average rainfall per year 8.63 inches.

Minimum		Maximum
0.83	(Producing runoff in July, August, and September)	4.93
4.63	(Annual)	11.05

From the available rainfall records at Kayenta, we find that more generally five rains occur during the period July, August, and September, amounting to one-quarter of an inch or more. Therefore, in figuring the probable available water from runoff to the farms, it is assumed that we get five one-half inch rains for growing season. Also that a rain of one-half inch per hour will produce the amount of runoff expected.

For purposes of considering structures for spreading areas or other diversions, a rainfall of three inches per hour will be assumed.

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