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January 31, 1923

IRRIGATION PROJECT

for

Hopi Indians

on the

FIRST MESA WASH
Arizona.

OFFICE
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FEB - 8 1923
10965

H. F. Robinson,
Supervising Engineer,
January 31, 1923.

CHIEF ENGINEER,
RECEIVED
FEB 8 1923
U. S. INDIAN SERVICE

RG75, BIA, CCF
10965-1923-341
Hopi
Box 20

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# DEPARTMENT OF THE INTERIOR

UNITED STATES INDIAN FIELD SERVICE

Office of Supervising Engineer,
310 Federal Building,
Albuquerque, New Mexico

JANUARY 31, 1923.

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CHIEF ENGINEER RECEIVED FEB 8 1923 U. S. INDIAN SERVICE

The Commissioner of Indian Affairs,
Washington, D. C.

Through the Chief Engineer.

Sir:

You are conversant to a greater or less degree with the situation in the Hopi country regarding the farming operations of these Indians, which have been carried on from time immemorial by the spreading of flood waters from the various washes on sandy land; and that because of erosion most of these washes are now so far below the surface of the ground that this water is not spread by nature and cannot be diverted by the Indians, as the depths now reached by the washes are too great for the Indians to do the necessary work, which has assumed the nature of a considerable engineering problem.

In former times, before the gullies and arroyos had formed, the floods spread out on the land where the Hopis raised their corn, melons and other crops. The sand covering formed an efficient mulch to conserve the water. Their farms covered nearly the whole valley east and south of the First Mesa, and only when there was a

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succession of dry years did their crops fail. The area over which the floods could spread has decreased from year to year as the washes have cut deeper and deeper, until now but a small fraction of their former farms remain available.

In those days as soon as a flood was observed to be coming, every farmer got out to the fields, and with only a hoe, the water was directed by means of small dykes thrown up as needed and by the time an ordinary freshet or flood had subsided every acre had been soaked and a crop assured.

In some parts of this country, notably at Oraibi, the erosion has gone to such a depth that it has uncovered the underground water, so we are confronted with the condition that not only is the periodical flooding of the land prevented, but the small amount of ground water is being drawn down to such a depth that it is of no assistance in agriculture. In connection with this you are requested to read the monograph sent you a few days ago written by Aldo Leopold of the Forest Service.

You will remember that we have done some work in the Wepo Wash to remedy this and have held this wash from cutting deep so that the water is still being spread over the land, but this is only a very small part of the lands that the Indians have to put under cultivation and the other lands are now becoming worthless to them as

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agricultural lands. As at least 50%, if not a greater proportion, of the living of these Indians is by agriculture, something must be done to assist them, either by giving them new farming lands, devising a way by which water can be taken out onto their present farming lands, or it will be necessary in a very few years to do something for them in the way of gratuitous subsistence in order that they may live.

It is true that this work should have been taken up years ago. We can now see where a comparatively small amount of work at that time would have saved big expenditures and heavy work at the present time or in the future but the conditions were not understood then, and no one foresaw the rapid erosion of these washes and the consequent damage to the farming areas of these Indians.

The entire cultivable lands of the Indians of the First and Second Mesas are now restricted to the land in the Hopo Wash, some land near what is known as the "Five Houses" which derives its water supply from some short washes from the mountains to the south, and a few other areas which are growing so dry that the crops raised are much less than they were formerly. The total area is much too small for the needs of these Indians.

We have made some investigations in the past several years and during the late fall months just passed certain surveys and examinations were made with the idea of diverting water from these washes to the lands of the

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Indians that we might open up new areas of agricultural land with water so the Indians might continue to live as an agricultural people.

The examinations made showed that the washes had all cut out to a depth of from 5 to 40 feet below the surface of the plains and that there are no places where any hard material or bedrock is within reasonable distance where there is sufficient land below it to justify construction.

Lying along the First Mesa Wash some distance from the First Mesa, there is a large area of land that could we have water on it would make valuable farms. Any attempt to water it must take into consideration the climatic conditions and the methods heretofore used by these Indians in cultivating their land. We cannot expect to have an irrigation system such as exists in other places where we can have water on tap at almost any season of the year. The system that the Indians have heretofore used has been to take advantage of the lands that have been wet by the spring runoff and to plant corn deep in the ground, depending upon the moisture in the soil to bring the corn through to the period of summer rains, when the additional flooding of the lands will mature the crops.

Anything that we do for them in this country must be along the same lines. The problem therefore resolves itself into the question of diverting the water

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from the washes and then spreading it over a large area of country so that it will, as nearly automatically as possible, irrigate the land at the two flood periods and enable the Indians by their own method of cultivation to mature their crops of corn and a few other garden plants.

In planning for this work we are met at the outset with several difficult problems:

First, the remote location, being about 100 miles from the railroad.

Second, the lack of any foundation for a dam, there being nothing so far as we can ascertain upon which to found a dam other than alluvial deposit.

Third, the difficulty of getting any material for construction other than a rather poor grade of stone and brush.

Fourth, the almost entire absence of any material from which concrete may be made, as the only stone within reasonable distance is a soft sandstone and there is an absolute absence of gravel and coarse sand for concrete aggregate.

Taking all of these things into consideration, we have evolved in this office a system of construction that we believe will be adequate and will to a certain extent restore the normal conditions under which these Indians have conducted their farming operations in the past.

The plan in general consists of building a diversion in the First Mesa Wash. The water so diverted

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will be conducted through a canal about five miles long, with some three or more openings by which the water will automatically be distributed to the land. The canal will carry the water back to the edge of the foothills and the general slope of the country is parallel to the Wash. A profile across the valley shows higher land near the wash than there will be closer to the foothills. This will be of great assistance in handling the water as it will not readily return to the wash in any concentrated quantity that would erode, but will spread over the entire flat and any surplus will work parallel to the stream until it reaches a point near Burro Springs, where there is an outcropping of harder material and if there is any surplus water, it will go back into the stream with a minimum of erosion.

While the entire proposition is rather unusual and the plans for the diversion dam are rather novel, after thoroughly going into the subject, it is believed that the plans submitted will be adequate and reasonably safe.

The material for the construction will be iron pipe posts, heavy fencing wire attached to the posts in double parallel lines, and the intervals between the two lines of fencing would be filled with rock and brush. These will be built back in steps so the water that is not diverted will not have a large fall at any place. It is believed that we can so arrange the details of construction that we will be assisted by nature in the construction

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instead of constantly fighting her to secure the desired results. In short, the idea is to put in a low obstruction in the stream, allowing the first floods to deposit silt in andaround and behind the structures, then build another lift or structure which will again be cemented by the deposit of silt and so on until the stream channel is sufficiently high to divert water into the constructed canal.

It is believed that this form of construction could scarcely be built at one time, excepting with largely increased costs for material and labor as well as much more danger of the structure being damaged by the successive flood discharges.

We cannot expect to take into the canal the entire volume of the large floods, hence must plan to allow them to pass over the dam, although the entire flow of the smaller floods can pass into the canal and out onto the lands. The iron posts, it is believed, will be sufficient to carry the weight and pressure brought against them until they are entirely silted in. The wire fencing will be ample to hold the stone and brush. The pipes will have holes drilled through them to allow the wire mesh to be attached with wires, and in every case the mesh will be placed on the upstream side of the posts so the pressure will be carried by the posts and not by the wire ties.

At the lower end the construction will be spread out with a brush mat and stone paving between the fence rows

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that the water will reach normal velocities and erosion will be reduced to a minimum. Below the lowest fence will be placed masses of stone held in wire bags, the idea being to provide a method by which any cutting or unequal settlement could be cared for, as each of the bags of stone may settle independently, or at either end, and yet the stone will be held in the one mass without the use of concrete or grout, or the bringing in of individual stones of sufficient weight to be held there.

In turning the water from the canal, the plans submitted call for two openings, from each of which, by an overflow weir on top of the wooden gates, there will automatically be delivered from 1/4 to 1/3 of the canal capacity while the remainder will run out of the end of the canal. I am not entirely satisfied that this construction is the best, as it will throw out such large quantities of water at one place, and it may be much better to put in a comparatively large number of small gates delivering not to exceed four or five second feet at any one place.

A standard 15" corrugated pipe through the bank to which is attached a metal headgate, using the standard small lateral gate we have in on several projects, will deliver from 5 to 8 second feet according to the head. By placing these every quarter of a mile from Station 50 to Station 248, fifteen turnouts, we will secure a discharge of from 75 to 90 second feet which

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will be ample while the estimated cost will be about $167,[illegible] less than the two large gates planned. It is to determine the most efficient method of distributing this water, and the ease with which it may be handled by the Indians as well as the liability of the concentrated water to escape control and to erode the land and reach the main wash in such quantities that it would be destructive, and there are good arguments for both methods of construction. After locating the canal on the ground, a more particular examination of the lay of the land could come much closer to a determination of this than we can just now. However, this detail might remain in abeyance for the time being and need not affect the consideration of the plan as a whole.

Mr. Jackson has made a detailed report as to the construction of the various features of the project, and it is not necessary to repeat them, as a copy of his report is annexed as a part of this.

This project with the proposed construction has been considered in all of its phases, has been looked into by a number of the employees of this service and I have also consulted several of the engineers and others of the Forest Service, and it is the concensus of opinion that the project is well conceived; that the proposed construction will work and will be sufficient for the purposes planned.

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There is no question but what the Indians are greatly in need of this assistance, and each year that this work is delayed the difficulties and costs will increase. If this or some similar work is not done these Indians will soon reach a point of almost destitution and subsistence will have to be furnished to them, and they will no longer be a self-supporting people.

The encroachments of the Navajos have practically prohibited any further expansion of their stock raising from lack of range and almost all chance for agriculture is gone, and will be entirely gone for the people of the First Mesa at least, without this assistance.

It is believed that this project will place at least 3000 acres under cultivation at a cost of about $9.75 per acre, which is very reasonable. So far as can be seen at this time, and after a study of the matter for a number of years, this or some similar construction is all that can be done for these people so they may continue to be self-supporting.

It is therefore recommended that this project be built and that the sum of $30,000 be appropriated therefor, and that the work be commenced at as early a date as possible.

It is believed that the appropriations from the fund, "Irrigation, Indian Reservations, Reimbursable," and authorized specifically for "Miscellaneous Navajo and Hopi," which already specifically mentions the three great

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washes of this country, the Polacca Wash mentioned being another name for what is herein termed the First Mesa Wash, is applicable, and it is further believed that of the $9,000 authorized for this work for the present fiscal year, between $6,000 and $7,000 might be made available for this particular work, without detriment to other work on these reservations, and it is requested, that if this work is approved, that authority be given that a commencement can be made on this work during the present winter or spring, or as soon as possible, and the work can then be continued during the next fiscal year from similar funds that the project may be completed as rapidly as possible.

Yours very truly,

W. F. Robinson

Supervising Engineer.

WFR:H

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January 31, 1923



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DEPARTMENT OF THE INTERIOR

UNITED STATES INDIAN FIELD SERVICE

Albuquerque, New Mexico.
January 24, 1923.

Mr. H. F. Robinson, Supervising Engineer,
510 Federal Building,
Albuquerque, New Mexico.

Dear Sir:

During the months of September and October, 1922, investigations were made as to the feasibility, ways and means of getting the snow and flood water of the First Mesa Wash near Polacca, Arizona, Hopi Indian Reservation, out on the irrigable lands adjoining.

A rough reconnaissance of the Oraibi Wash, at a point 12 or 15 miles above Oraibi, Arizona, on the same reservation, was also made.

[illegible].

The Hopi Reservation is located in northeastern Arizona, in Townships 21 to 35 inclusive, North, Ranges 15 to 23 inclusive, East, Gila and Salt River Base Principal Meridian. The altitude ranges from 5000 to 6000 feet above sea level. The mean annual rainfall is about 6 inches.

The larger percentage of the Hopis are dependent on farming for a living. There not being enough rainfall for the growing of crops, farming can only be done where washes spread out and flood the land. Formerly, a large area was thus flooded, but within the last 10 to 20 years the majority of the washes, especially the larger ones

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which carry run-off, both snow and flood water, from long distances, have gradually concentrated and cut down until they are from 10 to 30 feet deep. This was caused by the depositing of silt and sand until the land was so built up that the water had to concentrate and go lower to get sufficient velocity to carry the silt and sand. The Indians are unable to divert the water from the deep washes. Every year more and more land is being lost in this manner. At present the Indians are greatly in need of more farm land and as the percentage of loss increases each year, within a short time - probably not more than ten years - they will come to a point of such need that they will starve without outside assistance. Now is the time to forestall this condition. In fact, if something had been done 10 or 15 years ago, the cost would have been far less than at present.

Within 4 to 15 miles below Polacca on the left of the wash, it is possible to flood about 5500 acres of land. The flooding of 3000 acres is considered in this report.

LAND AND SOIL.

The cost of leveling the land will be small, as in general the valley is almost level in cross section. Clearing the land will be a negligible factor as only a small part of it has a growth of small brush. The grazing is good.

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The soil is, for a depth of 10 to 150 feet, depending on the distance above rock outcroppings, composed of medium fine sand, shale and adobe. Much of it is stratified, though in many places the deposits are very irregular. The basin is being filled with shale, disintegrated sandstone, etc. from the surrounding hills andmesas.

One second foot of water, falling from the bank into a wash, will within a few hours cut bank 10 to 15 feet to a depth of 5 to 15 feet. The soil breaks vertically and great masses fall from the banks of the washes during the flood flow. The solid content of the flowing water is enormous. The velocity of the water in the main washes is from 5 to 7 feet per second, which gives a great carrying power.

SOURCES AND AMOUNT OF WATER SUPPLY.

The drainage area above the proposed dam is about 200 square miles. The maximum run-off per square mile is estimated at 7.5 second feet. During the winter and early spring there is a good flow of snow water from the mountains, amounting to from 1/2 to 3/4 of the rain flood flow. The rainy season occurs from July to September. The maximum flow of the First Mesa Wash during this time is about 1500 second feet. It is estimated that there will be a flow of water in the wash for an average of 200 days each year. With a possible maximum diversion of 150 second

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feet and being able to divert up to 150 second feet of all flows under 2 feet in depth, 15000 acre feet per year, or 5 acre feet per acre for 3000 acres can easily be diverted. This is sufficient land for the Hopis in this vicinity.

ALKALI.

Although alkali is present in the soil and shows where there is a fairly constant flow of surface water, the lands that would be cultivated are so well drained that the alkali would not do any damage.

CROPS.

Corn, melons and garden truck are the main crops grown. The crops are grown on the sandy soil deposited by the spreading out of the flood waters of the washes. This sand is neither coarse enough to allow free percolation nor fine enough to have any appreciable amount of capillary action. The other soils crack when drying up and soon lose all moisture by percolation and evaporation. It is also much easier to cultivate and get plant growth started on the sandy land. Water diverted from the wash will carry a comparatively large percentage of silt and sand and will very soon deposit enough of it to make a good soil on all land flooded.

IRRIGATION.

Near the center of Section 33, Township 28 North, Range 16 East, about 3 miles below Polacca, on the First Mesa Wash, it is proposed to construct a dam composed of a

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series of wire mesh fences across the wash.

Three double fences are first to be placed across the wash. The downstream fence is to be 4'7" high with the top at the ground surface; the posts are to be 4" pipe an average of 5' apart, the downstream post to be guyed to the one in the rear.

Below this first fence and attached to it are to be wire mesh sacks filled with stone, 10' long, 4' wide, 1' thick and underlaid with 1' of brush mat.

The space between the two lower fences is to be paved with loose stone, underlaid with 1' of brush mat. The surface of the stone is to be level with the tops of the fences at each end.

The next fence is to be 20' upstream and similar to the first excepting that it is to be 5'7" high, 1'7" of it above the ground surface. These fences are to extend about half way up the bank.

A third fence, 15' above the ground, similar to it excepting that it is to be 6'9" high, the top to be 2'9" above above the ground surface, is to be built. It will extend well past the tops of the banks on each side and will have the upstream post guyed to a 1" deadman back of it.

The fences of the double fence s are to be 3' apart center to center of posts, all fencing to be on the upstream side of the posts. The space between the fences are to be filled with loose stone from top to bottom of the wire mesh. On top of this stone a 28" width strand of wire

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mesh fencing is to be laid and fastened to posts on each side.

Holes are to be bored in the pipe posts at the point at which the top and the bottom of each strand of wire mesh fencing is to be attached. Annealed wire, the same as used for guy wires, is to be used to fasten the fencing to the posts, the wire to be run through the holes in the posts and wrapped around the posts.

Between the second and the third fences stone pavement flush with the ground surface is to be laid, the pavement to be curved up at the lower end to meet the top of the fence, forming a water cushion 1'7" deep. This pavement is to be underlaid with 1' of brush mat.

Upstream and adjoining the third fence, loose stones, sloping from the top of the fence back to a width of 4'7" at the bottom, is to be laid.

All of the above construction is to be done between the snow flood and the rainy seasons.

After the wash above the upstream fence is silted up, if possible during the rainy season, the fourth fence is to be built, 4'7" upstream from the third fence. It is to be similar to the third excepting that it is to be 7'6" high, the top being 3'5" above ground.

The remaining half of the space between the third and fourth fences is to be filled with loose stone and the stone covered with wire mesh fencing. The back of the stone fill between the fences is to be 7" lower than the

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top of the downstream fence of the adjoining downstream double fence.

When possible, after the wash is filled with silt above the fourth fence, the fifth fence, similar in all respect to the fourth, is to be built.

Likewise the sixth fence, which is to be similar to the fifth, excepting that it is to be 7'6" high, the top being 3'6" above ground.

When the wire and posts begin to fail the stone is to be grouted.

DISTRIBUTION SYSTEM.

HEADGATE. At the dam, a 12' radial gate (Hardesty Mfg. Co., Denver, Colorado, Model No. 181) is to be installed.

CANAL. The canal is not to have a bank on the upper side. The silt in the water will soon form a bank.

Data for the first 5000' of the canal: "s"-.001, "n"-.025, side slope 1 to 1, "b"-12.0', depth of water - 3.0', "A"-49.5 square feet, "v"-3.1' second, "Q"-153.3 second feet cut at station 0+00 (actually at station 1+00 - cut from 0+00 to 1+00 will be less than 14.0' - thus estimate of yardage is high) 14.0', cut at station 50+00 - 2.0'.

From station 50+00 to station 193+00, "b"-10.0', "v"-3.0'/second, "A"-43.5 square feet, "Q"-130.5 second feet, other data the same as in the previous section.

From station 193+00 to 254+00 (end), "b"-8.0', "A" 33.34 square feet, "v" 2.75'/second, "Q"-92.0 second feet, other data the same as in the previous section.

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At stations 50+00 and 193+00 turnouts are to be constructed, each of which will have a discharge of 1/3 of the capacity of the canal when the canal is running at full capacity. This with the gates of the turnout closed. The turnout can be completely closed by the use of flashboards.

The turnouts are to be of lumber with two gates, each 5.0' wide. Each will have an apron and wing walls to prevent the bank of the canal from washing out. A row of sheet piling across the canal will check erosion in the bottom of the canal. Stone pavement at the outlets will prevent erosion at these points.

The water from the turnouts will be discharged 2!0' below the ground surface, but short shallow ditches will carry it to the ground surface. (Cost of these ditches not included in estimate.)

Water from the end of the canal will spread over a valley, 1000 to 3000 feet wide and five miles long, with no well defined outlet to the wash.

MAINTENANCE.

This is the most important item concerning the project. If it isneglected the work of diversion will be lost in a year or two. The water, after being turned out on the land, must not be allowed to concentrate. Sand will be deposited where the water first spreads out. Late a stream bed will be made through this deposit if small dikes and

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ditches are not built to take care of the water. Cutting back from the banks of the wash by waste water must be prevented.

The Indians must have a leader who sees the importance of maintenance and feels his responsibility, who can convince the Indians of the great need of maintenance and get them to work at it unceasingly. In the beginning, each flooding must be watched and after it is gone, preparation made for the next. As the Indians come to understand the work and its importance and as more is learned as to how it should be done, there will be less to do, although the time will not come when maintenance will not be a big proposition. If it cannot be assured that maintenance work of the right kind will be done it is not worth while to make the diversion.

CRAIBI WASH.

About 12 miles above Craibi Wash there is a good place to make a comparatively cheap diversion of the flood water. On account of an outcropping of rock, the wash is only 5 feet deep at this point. A concrete dam 4 feet high and 150 feet long would make the diversion. If desired, shoulders at the end would form a spillway. On the left a canal of 100 square feet cross section and 1200 feet long would flood 500 acres of land. On the right, a canal of 100 square feet cross section and about 1 mile long would flood 500 acres more. With the use of a spillway, the

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cross-sectional area of the canals might be reduced. The maintenance problem previously mentioned would obtain here.

The importance of doing something as soon as possible should be emphasized. The sooner work is begun the less will be the cost. There is absolutely no doubt but that the Hopi farmers will have to be helped eventually, in some way.

Respectfully submitted,

O. K. Jackson (Signed)

Superintendent of Construction.

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