

P. 49 of log
Annual Report
1930

1305

38

GAMADO PROJECT

The principal work on the Gamado Project for the past year consisted of the regular operation and maintenance of the project. Funds appropriated for operation and maintenance of this project were in the sum of \$3,000 which would not permit any extensive repairs or replacements on the project..

The Indians farming on this project have shown an unusual interest in project affairs and regular monthly meetings were held with the Indians at which time project affairs and other matters of vital importance to the Indians were discussed.

The Indians have releveled a considerable acreage on the project and have in general improved their methods of cultivation and irrigation. In some cases where flood method of irrigation has been used the Indians have corrugated their fields and thereby conserved a considerable quantity of water which in turn increased crop production as in a number of instances where flood methods have been used for a number of years the alfalfa fields have been flooded to a point where the alfalfa has been killed and grass propagated in the fields. On the J. L. Hubbell ranch where flood methods have been practiced for the past

twenty years his entire alfalfa field consisting of some one hundred acres has been damaged beyond any possible chance of restoration and it will be necessary for him to plow up the entire field and plant to small grain crops for at least one year before reseeding alfalfa. It is believed that the Indians will profit by his experience and that better irrigation practices will prevail on the project.

Mr. Neil Campbell, who was sub foreman on the Pine River Project for a number of years, was transferred to the Ganado Project during the month of February 1930.

Mr. Campbell has made a good showing on this project, particularly in the Indians' affairs and in the building up of the irrigation plant, and because of his very great interest in the project he has been promoted from sub foreman to the position of foreman.

The Ganado Mission and J. L. Hubbell, the only two white users on the project, have performed their proportionate share of the cost of operation and maintenance in the cleaning of the canals. Reference is made to our annual report of 1929, page 53, for contract under which J. L. Hubbell and the Ganado

Mission receive irrigation water.

It is hoped that both the Mission and the Hubbell ranch will pay for operation and maintenance on a cash basis in the very near future.

MOENCOPI PROJECT

This project is located three miles southeast of Tuba City, Arizona, on Moencopi Wash, and irrigates lands for the Navajo Indians and the school farm. In addition to this the agency has about 150 acres of land in pasture.

A sluiceway was installed in the canal just below the school farm to facilitate in sluicing out sand and other silt deposit which accumulates in the main irrigation canal. The Western Navajo Agency paid for the labor and this Service furnished the gates. This work was started October 15th and completed on October 23rd.

RED LAKE PROJECT

This is one of the oldest projects on the Navajo reservation, originally built prior to 1904. Very little use was made of the project up to 1928. During the time it was originally constructed and the time the Indians began to make use of it, it has been practically rebuilt twice. There are 700 acres of good agricultural land available for cultivation with a reservoir containing 4000 acre feet of water. The reservoir has been filled to capacity for the past eight months.

The Fort Defiance School has forty acres under cultivation and every effort is being made to have the Navajo Indians place all of the agricultural lands under cultivation during the present season.

The project consists of a diversion dam and feeder canal to the reservoir with a storage capacity of 4270 acre feet and about five miles of main canal.

The project is visited regularly by a representative of the Fifth Irrigation District, however, the management of the project is vested in the superintenders of the Southern Navajo jurisdiction and not in this Service.

WATER DEVELOPMENT, NAVAJO AND HOPI RESERVATIONS

The Navajo reservation lies in one tract in northwestern New Mexico and northeastern Arizona and has an area of approximately 14,360,000 acres. The Hopi reservation lies in the heart of the Navajo country in Arizona and has an area of approximately 2,270,300 acres. The elevation varies from 4000 to 8000 feet with the higher elevations in the mountains. The rainfall varies from four to fourteen inches per annum.

Practically all of the area occupied by the Navajo and Hopi reservations is in an arid district and there is very little area that is fed by living waters. This area is confined to the west slope of the Choiska range and the area adjacent to the San Juan River. All of the other streams flowing through the Navajo country can be classed either as ephemeral or streams having an intermittent flow.

The work on the Navajo and Hopi reservations consists of the development of domestic and stock water for the entire reservations including Executive Order lands and lands acquired otherwise by the Indians. (Reference Office letter of March 7, 1930, Irrigation 6355-30).

The Navajo and Hopi reservations are divided into six jurisdictions: Eastern, Western, Northern, Southern, Leupp, and Hopi. Headquarters for the water development work are at Polacca, Arizona, on the Hopi reservation, and the organization is shown on the Organization Chart.

Water for domestic and stock purposes is developed by drilling wells and equipping them with windmills, storage tanks, and watering troughs; developing springs and piping the water from the springs into a concrete or less permanent water trough, depending upon the funds available, and the construction of earthen reservoirs to impound surface and flood waters. The dams forming the earthen reservoirs are riprapped on both slopes to prevent wind and water erosion and also to prevent wear and tear on the embankments where sheep and other livestock come to water. The work also includes the operation and maintenance of the existing wells, springs, and reservoirs.

Water development on the Navajo reservation has been in progress for some twenty years and it is now found necessary to replace the well casings which have rusted out in a number of wells which were drilled during

the early period of the water development.

During the period that the development of stock water has been in progress, the Navajo Indians have increased their flocks to such an extent that the demand for stock water in the remote districts of the reservations has been very great. The increase in flocks has been so rapid that the range has been depleted adjacent to the water holes developed to such an extent that about 25% stand of natural grass remains and for many years the grass has not been allowed to reseed itself. The only good range on the Navajo reservation is in districts where stock water has not been developed and it is believed that most of this area should be retained as it is and used only during a period when natural conditions would permit of its use, otherwise the entire reservation will be overgrazed within a very short time.

Considerable attention is now being devoted to redistricting the range on the Navajo and Hopi reservations in order to provide winter and summer range and permit, if possible, the reseeding of the portions of the reservations that are now overgrazed.

The redistricting and developing of the range has recently been turned over to the Forest Department of the Indian Service.

The following summary shows the water development during the fiscal year 1930:

Springs Developed

<u>Northern</u>	<u>Southern</u>	<u>Western</u>	<u>Eastern</u>	<u>Hopi</u>	<u>Leupp</u>	
9	17	3	1	3		
						TOTAL 33

Reservoirs

<u>Western</u>	<u>Eastern</u>	<u>Hopi</u>	
12	4	2	
			TOTAL 18

Wells

<u>Northern</u>	<u>Southern</u>	<u>Western</u>	<u>Eastern</u>	<u>Hopi</u>	
16	16	7	4	1	
					TOTAL 44

1300

Ganado Project

Employee in Charge: Neil Campbell, Foreman.

This project is located on the Navajo Reservation. Water is diverted from the Rio Pueblo Colorado and impounded in a reservoir which has a present capacity of approximately 2,600 acre feet. There are 9.69 miles of main canal and 3 miles of laterals. The gross irrigable area of the project is 1,200 acres of which 800 acres are under constructed canals and can be served with the present capacity of the reservoir. During the past irrigation season the Indians irrigated 494 acres and in addition to this 156 acres were irrigated by J. L. Hubbell and the Presbyterian Mission. Crops produced by the Indians were valued at \$19,019.74.

On the afternoon of July 28, 1931 a rain storm of cloudburst proportions, followed by hail, wind, and a flood, swept the vicinity of the project and wrought serious damage to the system and some of the farm crops. The diversion dam, a rock-filled crib, was carried out in its entirety. A section of the main canal near its head was washed out and a flume structure across the Rio Pueblo Colorado was destroyed. Several other flumes across smaller arroyos were also damaged. The hail did not cover the entire area but damaged only a

REPRODUCED AT THE NATIONAL ARCHIVES

strip near the upper end of the project.

The reservoir was not damaged and gained three feet of water during the storm.

A survey of the damage was made and plans submitted for the rehabilitation of the irrigation system. The area under the south side canal was without irrigation water for the balance of the season but intermittent showers helped to produce an average crop. Delivery of water was made on the north side for the balance of the season.

The earth work for the repair of the section of the main canal which was washed out was contracted to the Indians farming on the project. Work was commenced in November but was not completed until March on account of the severity of the winter.

All Indian livestock suffered to a great extent during the winter because of the deep snows, but the Indians on the Ganado Project were in a position to provide some feed, while in other sections it was necessary to haul it in from the railroad.

This year the Indians farming under the project have paid \$1.00 per acre operation and maintenance charges.

COMPARISON CONSTRUCTION PROGRAM AND PROGRESS

Ganado Project F. Y. 1932

Source and Disposition of Funds:

	Estimates F. Y. 1933 (Work Program)	Fiscal Year to Date
<u>From Appropriations:</u>		
F. Y. 1931 unobligated balance 7-1-31		
F. Y. 1932, available Def. Apprn.	\$12,972.00	
Expenditures and obligations	12,972.00	\$12,972.00
Forward to F. Y. 1933	None	
<u>From Collections:</u>		
	None	

Summary: Programs of Work and Progress to Date

Project Features	Estimated Cost F. Y. Work Program	Actual Cost	% of Estimate
*Diversion Dam	\$10,672.00	\$11,447.65	107%
*Distribution	2,300.00	2,610.24	113%
*No Program			
Totals	\$12,972.00	\$14,057.89	

Comments on Items of Work, Construction.

In the rebuilding of the diversion dam, the channel as eroded by the flood was changed to direct it over a rock ledge. On this ledge was constructed the structure for the radial sluice gate, the twin head gates, and the ogee spillway section 190 feet long which was twice the length of the original spillway. Retaining walls to confine the flow and protect the embankment are of concrete. The feeder canal for the reservoir was lined with concrete from the head gates for a distance of 347 feet.

An embankment of 8,000 cubic yards of earth was placed across the old channel of the river, and that portion of the upstream side exposed to the current was blanketed with rock. The earth for this embankment was conveyed 200 yards from a 4-yard trap by two dump trucks. The loading of the trap was contracted to the Indians at 20¢ per cubic yard and the work was done with teams and fresnos.

A 24-inch steel pipe siphon was placed below the bed of the river to replace the flume structure washed out by the flood. A sand trap with sluice gate was constructed just above the intake of the siphon. This should eliminate any trouble of silting

in the siphon. This construction work was commenced April 4th and completed May 26th.

Indians from every section of the reservation benefited by the work done here as they were given preference in any class of work for which they might qualify.

Comments on Items of Work, Operation and Maintenance

To assure an adequate supply of water for the present irrigation season, a temporary diversion of the spring run-off of the Rio Pueblo Colorado was made February 18th and with constant patrol the filling of the reservoir was accomplished.

Operation of the canal for the irrigation season of 1932 was commenced May 26th.

Crystal ProjectComments on Items of Work, Operation & Maintenance

This project is located 30 miles north of Fort Defiance on the Navajo Reservation in New Mexico and receives its water from Crystal Creek where there is an abundance of water for the irrigation of all the irrigable lands. The system consists of a crib diversion dam, 5 miles of main canals, and 4 flumes.

During the past season the Indians cultivated 157 acres, producing crops valued at \$5,595.

A short section of canal was lined, 2 flumes constructed and one flume repaired. This will permit the Indians to extend their irrigation canals.

Moencopi Wash Project

Comments on Items of Work, Operation & Maintenance

This project is near Tuba City on the Navajo Reservation in Arizona. The water supply is from an ephemeral stream of the same name and the system consists of a diversion dam and three miles of main canal, of which 2,300 feet are concrete lined.

The general maintenance work necessary on the project this year was the raising of the head gate structure as it had been topped by floods several times in the last two years, filling the canal below with great quantities of debris and silt.

The canal lining is in a bad state of repair and the 1933 program provides for its repair and extension.

Red Lake ProjectComments on Items of Work, Construction

This project is located 15 miles north of Fort Defiance on the Navajo Reservation in Arizona. The system consists of a diversion dam, feeder canal, a storage reservoir having a capacity of approximately 4,500 acre feet, and 3 miles of main canal. There are 700 acres of irrigable land with only 98 acres reported under cultivation during the past season.

To properly develop the project the completion of the main canal and principal laterals with proper turnout gates was undertaken because it has been found that very little can be left for the Indians to do without proper supervision and aid. Excavation of the canals was contracted to the Indians living in the vicinity. This work was started in November under the supervision of Foreman Campbell but because of the severe winter was not completed until spring. Betterments were made to the outlet structure of the reservoir as immediate repairs were necessary to insure service for the present season.

COMPARISON CONSTRUCTION PROGRAM AND PROGRESS

hed Lake Project F. Y. 1932

Source and Disposition of Funds:

	Estimates F. Y. 1933 (Work Program)	Fiscal Year to Date
<u>From Appropriations:</u>		
F. Y. 1931 unobligated balance 7-1-31		
F. Y. 1932, available 7-1-31	\$1,500.00	
Expenditures and obligations	1,500.00	\$1,789.35
Forward to F. Y. 1933	None	
<u>From Collections:</u>		
	None	

Summary: Programs of Work and Progress to Date

Project Features	Estimated Cost F. Y. Work Program	Actual Cost	% of Estimate
Lateral System	\$1,500.00	\$2,229.21	148%
Totals	\$1,500.00	\$2,229.21	

Wheatfields Project

This project located 35 miles north of Fort Defiance, Arizona, was constructed in 1909 and consisted of a log crib diversion dam, feeder canal, and storage reservoir. No beneficial use was made of this project due to the fact that about the time it was completed a member of the engineering force was killed by lightning on the dam. The Navajo Indians, being superstitious especially where one is killed by lightning, would have nothing to do with the project and it remained unused. The diversion dam was completely destroyed, the feeder canal was never completed, and the part excavated was filled with silt. With the exception of the head gate structure the storage dam was in excellent condition.

COMPARISON CONSTRUCTION PROGRAM AND PROGRESS

Wheatfields Project F. Y. 1932

Source and Disposition of Funds:

	Estimates F. Y. 1933 (Work Program)	Fiscal Year to Date
<u>From Appropriations:</u>		
F. Y. 1932 unobligated balance 7-1-31		
F. Y. 1932, available 7-1-31	\$10,000.00	
Expenditures and obligations	10,000.00	\$10,290.86
Forward to F. Y. 1933	None	
<u>From Collections:</u>		
	None	

Summary: Programs of Work and Progress to Date

Project Features	Estimated Cost F. Y. Work Program	Actual Cost	% of Estimate
Storage Dam	\$3,338.75	\$2,852.50	85%
Distributary System:			
Diversion Works	3,261.25	2,660.27	81%
Canals & Laterals	3,400.00	1,966.26	57%
Totals	\$10,000.00	\$7,479.03	

Comments on Items of Work, Construction

The project was rehabilitated during the fiscal year. A new head gate structure was built in lieu of a diversion dam, the feeder canal was reconstructed, and the storage dam provided with a new head gate and spillway structure.

The storage capacity of the storage dam is 997.9 acre feet which is sufficient to irrigate 375 acres of irrigable land under the project.

Water Supply, Navajo and Hopi

Employee in Charge: A. H. Womack, General Foreman.

The Navajo and Hopi Reservations which lie in extremely arid parts of New Mexico and Arizona have a combined area of 14,360,000 acres. Very little live water is found in this area making it necessary to develop springs, drill wells and equip them with windmills, tanks, and troughs, and construct earthen reservoirs for the development of stock and domestic water. The Navajo tribe is one of the few in the Southwest which has increased rapidly in population and in turn has increased its herds until all of the areas adjacent to water supplies have been overgrazed and present at this time a very difficult problem. This must be met by either reducing their herds or increasing the amount of funds for water development in order to supply forage for stock in areas heretofore unused due to the fact that there has been no water available for livestock or domestic use. This area comprises at least 30% of the reservation and approximately 50% of the area is only partially developed.

During the past year contracts were made with the Indians to construct earthen dams to impound water for stock purposes. The Indians were paid at the rate of 20¢ per cubic yard and very satisfactory results were obtained by this method of construction.

COMPARISON CONSTRUCTION PROGRAM AND PROGRESS
 Water Supply, Navajo & Hopi
 Domestic & Stock Water Development Project F. Y. 1933

Source and Disposition of Funds:

	Estimates F. Y. 1933 (Work Program)	Fiscal Year to Date
<u>From Appropriations:</u>		
F. Y. 1931 unobligated balance 7-1-31		
F. Y. 1932, available 7-1-31	\$90,325.00	
Expenditures and obligations	90,325.00	
Forward to F. Y. 1933	None	
<u>From Collections:</u>		
	None	

Summary: Programs of Work and Progress to Date

Project Features	Estimated Cost F. Y. Work Program	Actual Cost	% of Estimate
Reservoirs	\$32,112.00	\$20,438.68	63%
Wells, Drilled	12,110.00	19,981.39	164%
Springs, dug wells and concrete troughs	46,103.00	44,317.50	96%
Totals	\$90,325.00	\$84,737.47	

Comments on Items of Work, Construction

During the past year the Indians built under contract six earthen reservoirs in the Northern Navajo Jurisdiction, six on Southern Navajo, one in Western Navajo, one in Eastern Navajo, and six in Hopi. In addition to this, six were constructed in Western Navajo Jurisdiction by machinery, making a total of twenty-six of this type of development.

The approved program of work for the year provided for two drilled wells in the Eastern Navajo Jurisdiction, one in Leupp, and one in Southern Navajo. All of these wells were drilled by contract.

In addition to the foregoing activities, sixteen springs and forty-three dug wells were completed by Government forces.

Water Development, Navajo & Hopi Reservations, F. Y. 1932

	Northern Navajo	Eastern Navajo	Southern Navajo	Western Navajo	Leupp	Hopi	Totals
Reservoirs	6	1	6	7	0	6	26
Springs	4	3	3	1	4	1	16
Dug Wells	21	0	11	4	7	0	43
Drilled Wells	0	2	1	0	1	0	4
Totals	31	6	21	12	12	7	89
Concrete troughs	22	12	13	5	6	4	62

Water Development, Navajo & Hopi Reservations, to June 30, 1932							
	Northern	Eastern	Southern	Western			
	Navajo	Navajo	Navajo	Navajo	Leupp	Hopi	Totals
Reservoirs	6	20	6	30	4	6	72
Springs	109	7	57	55	24	80	332
Dug Wells	80	4	61	32	15	16	208
Drilled Wells	6	2	33	3	5	27	76
Drilled Wells Art.	5	12	5	1	0	4	27
Totals	206	45	162	121	48	133	715
Concrete troughs	187	29	146	66	34	84	546

Comments on Items of Work, Operation & Maintenance

Regular maintenance of all windmills, tanks, and troughs in the Northern, Southern, Leupp, Western, and Hopi Jurisdictions was carried on by two crews throughout the year, one crew operating from Chin Lee, Arizona and the other from Polacca, Arizona.

1311 8

Ganado Project

Employee in Charge: Neil Campbell, Foreman.

Precipitation occurred on the project during the months of July, August, September, April, and June, supplying moisture which greatly assisted in the maturing of crops. One rain during June assumed cloudburst proportions on the lower part of the project and the resulting flood caused damage to the canal and some of the structures.

Operation

Diversion was made from the Rio Pueblo Colorado into the reservoir during the months of July, August, October, March, April, and June. The run-off was far below normal for the seasons of 1932 and 1933, permitting only limited delivery during July and August, returning to normal for the month of September with no further demand for the rest of the season. Beginning the season of 1933, water was turned into the canal May 8 but only a limited delivery was made on account of the low stage of the reservoir. This was continued throughout June but only gardens were irrigated.

Maintenance

Repairs to the diversion dam, reservoir, and distribution system during the year were of only a minor nature. Some work was done on the diversion dam during July and August, and to canal structures in March when the spring cleaning of the canal was done. Sixteen hundred feet of rock bank protection and brush

REPRODUCED AT THE NATIONAL ARCHIVES

riprap to canal banks were placed during April.

Major repairs were made to the project cottage, garage, and warehouse. This is the first work done on these buildings for many years, and these repairs were necessary, not only for general appearances, but also for the comfort of the man in charge.

In all this work the Indians farming on the project were given the first opportunity in order that they might earn sufficient money to pay their water charges which amount to \$1.00 an acre.

During the irrigation season of 1932 there were under cultivation 437.13 acres, of which 115.5 were non-Indian, and 321.63, Indian. It is estimated that the acreage for the 1933 season will be approximately the same.

Miscellaneous Navajo Projects

Employee in Charge: C. A. Burns, Engineer.

Choiska

The sum of \$2,000 was allotted for the completion of the distribution system on this project. This involved some additional excavation on the main canal, the excavation of the main lateral, and the construction of two concrete checks and drops. With the exception of these structures, the balance was to be expended for labor for the excavation of the canals.

Kinlechee

The 1932 operation and maintenance program carried the amount of \$500 for the replacement of the diversion dam, and the 1933 program, \$1,600 for the improvement of the distribution system. The original diversion dam was a log crib, rock-filled structure constructed in 1923. Continual maintenance was necessary on this structure and it was decided that a diversion dam of a more substantial type would be necessary, and that serious damage to crops might result if the failure of the old dam occurred before replacement was undertaken. The new dam is located upstream from the old structure where a projecting ledge provided a spillway through the rock and the construction of an earth embankment across the stream channel diverted its course to this spillway. The removal of the rock from the spillway after drilling and blasting, and the construction of the earth embankment,

was contracted to the Indians on this project for a nominal sum. An additional payment was made to the Indians when difficulties were encountered in the work. There were 900 cubic yards of earth moved to construct the embankment, and 305 square yards of rock placed on the upstream face of the embankment to prevent erosion.

To better the distribution system, two flumes were replaced with siphons. One flume on the main lateral crossed the Rio Pueblo Colorado 30 feet above the stream bed. This flume was 220 feet long and required continual maintenance. The other flume, on the main canal, crossed a deep arroyo 25 feet above the bottom, in a single span. This structure also caused much trouble and its replacement with a siphon will eliminate all the trouble experienced heretofore. Some assistance was rendered the Indians in the placing of these two siphons and all the work done was supervised by Foreman Campbell of the Ganado Project.

Moencopi Wash

There was \$4,500 allotted for the improvement of the main canal, the construction of two sand traps and sluice gates, and one water bridge to carry flood water over the canal. Work on the canal was done in August under the supervision of Instrumentman Mutz. All of the damaged canal lining was removed, the overburden through the deep cut was carried back from the canal banks, and the canal regraded for several hundred feet. The Agency

assisted in this work by loaning a tractor for the excavation.

On November 21, Foreman R. E. Frost commenced work on the canal structures. Two sand traps with sluice gates were constructed, one at station 17-00, and the other near the dairy barn several thousand feet below. At the location of the first structure a flume was built over the canal to carry flood water, this being a replacement of an old timber structure. Work was stopped in December on account of cold weather, and resumed in March and completed during that month.

Rook Point

There was allotted \$2,200 in the 1933 program for the improvement and betterment to the diversion dam of this Indian-built project located on a tributary of Chinle Creek on the Southern Navajo Jurisdiction. Work was started on March 24 and completed the first week in June. The site of the diversion dam is an exposed sandstone ledge. On this ledge was constructed a low concrete weir 60 feet long, and protecting wing walls. To divert the flow of the stream over this spillway an earth embankment was constructed across the channel and faced with a rock blanket to prevent erosion. The Indians farming on this project moved all of the earth to construct the embankment. The concrete work was under the supervision of General Foreman Bentley.

Segihotsooi

The sum of \$1,272 was provided in the 1933 program for the replacement of the diversion of this project, located in northern Arizona in the Western Navajo Jurisdiction. This project is situated in a narrow canyon and the source of water for irrigation is from springs. There are approximately 100 acres of irrigable land in this canyon and, with proper use, the flow of these springs is sufficient. Because of the narrowness of the canyon, floods are prevalent during the months of August and September and the maintenance of a heading has been a continual problem for the Indians. At the site of the diversion there is rock exposed for the entire width of the canyon floor. During times of flood this entire section is flooded. In the design for the diversion dam, particular attention was given to this fact so that at periods when only the flow of the springs was available all of this amount would be concentrated at the head gate, and at times of flood the water would be influenced to spread across the floor of the canyon. This was accomplished by extending the concrete weir and curving it away from the head gate. The excavation of the canal to connect with the existing system will be done by the Indians.

Surveys

The following preliminary surveys and investigations were made during the year: Round Hook, Lower Crystal, Black Hills, Drolet, Black Creek, Lukaohukai, in Southern Navajo; and, Mexican Water, Chinle, and Fruitland, in Northern Navajo.

Projects Not IrrigationLeupp School and Agency, Flood Protection and Drainage.

A program of levee construction and the extension of the span of the highway bridge was planned for the further protection of the Leupp School and Agency, in Arizona. Work was started March 22 with Instrumentman Skinner in charge of the earth work. The construction of the levees involved the moving of 39,350 cubic yards of earth, and Indian teams were used for the major part of this work. The construction of a section of the levee was allotted to a group of Indians and payment of a contract price of 25¢ per cubic yard was made. Three such contracts were made early in April. Work was started then and completed during May with a total of 22,000 cubic yards being moved. The average pay for these first contracts was \$3.80 a day for man and team. Three more contracts were made at the completion of the first units and were completed by the end of June. The total for all contracts was 37,663 cubic yards with an average earning for man and team of \$4.29 a day. Additional earth work necessary for the construction of approaches, spur dikes, and small units requiring long hauls, was done with day labor and the final unit cost was 50¢ per cubic yard. An interior drainage canal was surveyed but no work on this feature was done during this fiscal year.

The program provided for a 300-foot extension of the present

timber highway bridge. Excavation for this structure was started April 25 and was carried on during May. Tractors and rotary scrapers were used in this work. Concrete work on the bridge abutment and the footings was started May 31 with the pouring of the abutment footing. Erection of forms and the pouring of the abutment followed, and the pier footing was poured as rapidly as excavation was made. In the meantime the bridge timbers were being cut and placed ready for assembling. This feature was not completed at the end of the fiscal year.

Projects Not IrrigationShiprock Flood Protection

To protect the Northern Navajo Agency and School from the flood waters of the San Juan River, a pile and plank revetment 3,060 feet long backed with wire and rock sausages, and a drainage canal and levee approximately 11,000 feet long, were constructed. The preliminary excavation for the alignment of the revetment and the driving of the piles were contracted. Activities commenced April 10 and excavation amounted to 8,292 cubic yards. Creosoted piles 25 feet long were then driven at 6-foot centers, and a facing of creosoted planks bolted to the piles forming a continuous jetty 3,060 feet long and six feet high. The revetment is four to six feet from the bank line and the space behind was then filled with wire and rock sausages to the ground level. Cable anchors from each pile were carried back to the bank line and anchored to deadmen. Steel jetties, laced with wire, were placed along the toe of the revetment to check scour at this point. The contractor completed his work May 11 and the crew bolting on the planking completed its work soon after. All the wire and rock sausages were completed by the end of the fiscal year, but the fabrication and placing of the steel jetties was carried over into July.

On May 31, the dragline started excavation on the drainage canal and levee and at the close of June had removed 12,769

cubic yards of earth, or an average of 491 cubic yards per shift.
Three wasteway inlets to the drainage canal were constructed on
the section completed.

Water Supply ProjectsNavajo and HopiMaintenance

At the close of the fiscal year 1933 there was a total of 749 developments consisting of springs, dug wells, drilled wells, and artesian wells. These developments are divided among the jurisdictions as follows: Northern Navajo, 211; Eastern Navajo, 44; Southern Navajo, 174; Western Navajo, 129; Leupp, 51; and Hopi, 140.

Regular maintenance of these developments is necessary throughout the year, with particular attention paid to the wells equipped with windmills. For many years two crews have been doing this work, one operating from Polacca, and the other from Chinle, in Arizona. In addition to the regular work, it has been the practice for the past few years to have the spring development crews make a visit to those in their jurisdiction each year.

Construction

Four construction crews operated in the various jurisdictions during the entire fiscal year with the exception of a period of forty to sixty days during December, January, and February, when the cold weather was unfavorable for concrete work and the roads unsuitable for the movement of supplies and equipment, and during the months of May and June when all

construction activities were suspended for the remainder of the year. A table showing the number of developments by jurisdictions is placed at the end of this statement.

Northern Navajo

It had been planned to drill three or four wells in that section south of Farmington and near the east boundary of the reservation. Little or no work had been done in this district because of the lack of surface indications of water. The first well was drilled to a depth of 441 feet but was filled up to the 300-foot level as unsuitable water was encountered at the lower depth. A windmill was erected over the well and a tank and trough constructed. At the second site the driller went to 915 feet without encountering any water and this was abandoned. At the third site, operations were carried on to a depth of 400 feet without encountering water in sufficient quantities to warrant development. It was then decided to suspend drilling in this section for the rest of the year. The rig was moved to the Eastern Navajo jurisdiction. In addition to this activity there were developed three dug wells with concrete stock troughs. This brings the total number of developments in this jurisdiction to 211.

Eastern Navajo

After completing the program of drilling in Northern Navajo jurisdiction, the well rig was moved to the Church Rock Well, No. 553, early in November. The contractor of this development had

defaulted. To proceed with the operations it was first necessary to pull the casing and clear the hole before drilling could be continued. This was completed by January. A casing of smaller diameter was set and drilling continued to a depth of 1,675 feet where an artesian flow was encountered. At present this well is developing 330 gallons per minute.

Other activities were the construction of three stock water reservoirs and the development of one spring with concrete stock trough. The average capacity of two of the reservoirs is 15 acre feet for the movement of 2,945 cubic yards of earth, but on the third reservoir a 345-acre-foot capacity was secured and the earth embankment contains only 2,406 cubic yards. This brings the total number of developments in this jurisdiction to 44.

Southern Navajo

The total number of developments for the year was sixteen, three of which were stock water reservoirs constructed by Indian contractors, four were springs, and nine were dug wells. Of the nine wells, seven were equipped with windmills. Two of these developments were located at Chapter houses and will supply water for the laundry and bath house. The total number of developments is 174.

Western Navajo

There were three developments of reservoirs for stock water in this jurisdiction, two of which were constructed by Indian

contractors and the other by the tractor crew. Shortage of water in the vicinity of this third development made it necessary for the tractor crew to do the work. Other types developed were three springs and one dug well. This brings the total number of developments in this jurisdiction to 129.

Leupp

Only two new developments were completed, both dug wells. In addition, twelve concrete stock water troughs and four concrete storage tanks were constructed at the wells drilled during the previous year. The total number of developments on this jurisdiction is 51 which does not include the troughs and tanks.

Hopi

There were nine developments during the year, bringing the total on the jurisdiction to 140. Of the new developments, four were stock water reservoirs and five were springs. One of the springs was equipped with a windmill, concrete tank, and stock water troughs. The four reservoirs were constructed by Indian contractors.

Developments Completed During
the Fiscal Year 1933

	No. Nav.	East. Nav.	So. Nav.	West. Nav.	Leupp	Hopi	Totals
Reservoirs		3	3	3		4	13
Springs, with troughs		1	2	2		2	7
without troughs			2	1		2	5
with windmills						1	1
Dug Wells, with windmills			2	1			3
without windmills	3		7		2		12
Drilled wells, with windmills	1						1
without windmills		1					1
Troughs					12		12
Concrete storage tanks					4		4
Totals	4	5	16	7	18	9	59

Developments Completed to Date

	No. Nav.	East. Nav.	So. Nav.	West. Nav.	Leupp	Hopi	Totals
Reservoirs	6	21	10	39	4	10	90
Springs, with troughs	102	9	46	37	22	40	256
without troughs	6		9	18	3	40	76
with windmills			1			1	2
Dug wells, with windmills			3	5	5	1	14
without windmills	83	4	66	26	12	17	208
Drilled wells, with windmills	7		31	3	5	27	73
without windmills		1	1				2
Artesian wells, flowing	7	9	6	1		4	27
with windmills			1				1
Troughs	6	13			13		32
Concrete storage tanks					4		4
Totals	217	57	174	129	68	140	785

25-6
734