

Albuquerque, New Mexico
June 2, 1931

Subject: Flood Protection of Leupp Navajo Indian School,
Leupp, Arizona.

To: Commissioner of Indian Affairs,
Washington, D. C.

1. In response to your telegraphic instructions
of May 25, 1931, reading as follows:

"Wm. S. Post,
Director of Irrigation,
Leupp, Arizona

Regarding your investigation Leupp School may
state Congressional Committee Representative
and Budget Officer who recently visited school
were impressed with danger to buildings by
flood stop committee feels prompt action neces-
sary but reluctant to support legislation in-
volving abandonment of plant without abundant
supporting data period hence Dean Preston and
yourself appointed to thoroughly investigate
and report upon condition period Supervising
Engineer Neuffer visited school with us and
can furnish you additional data.

Rhoads"

a committee composed of William S. Post, Director of Irrigation,
Indian Service, Washington, D. C.; Porter J. Preston, Engineer,
Bureau of Reclamation, Denver, Colorado; and Lieut. John Paul
Dean, Corp of Engineers, Office of the Chief of Engineers, U. S.
Army, Washington, D. C., was convened at Leupp on May 25, 1931.

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General Description of the Location

2. The Leupp Indian School is located in the valley of the Little Colorado River, 27 miles northwest from Winslow, Arizona. It was established in 1911 and consists of a group of buildings covering an area of 30 acres, of which 26 are constructed of sandstone and the remainder are frame cottages. The School buildings include a power plant, and all are equipped with a domestic water supply and with sewer systems. The grounds are provided with sidewalks and streets, shade trees, shrubbery, and lawns. The administration of the Leupp Indian Jurisdiction is located here as well as the separate schools for boys and girls. The juvenile population amounts to about 400 persons between the ages of 8 to 16. The adult population is about 100. The Schools are maintained as boarding institutions, the children being separated from their parents during the school year. This places a great responsibility upon the superintendent and teachers to see that children of these ages are not subjected to any flood hazards. The security from floods must be such as to relieve the fears of the parents. The effective workmen in case of emergency consists of about 10 men out of the personnel of the Agency. The nearest assistance as to labor or materials is at Winslow, 27 miles distant. The telephone communication is only part-time to Canyon Diablo; from there communication with the outside world must be made by telegraph.

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History of the School

3. The Leupp School was established in 1911 with a capacity of approximately 70 pupils. In 1921 a plan was formulated to enlarge the School, increasing the capacity to 400 and this construction program was carried on for several years and at this time much has been done towards the completion of same. The construction costs of the buildings are carried at a value of approximately \$325,000. The present replacement value is probably not less than \$400,000. This includes improvements in grounds, water and sewer systems, but excludes equipment which could in the main be salvaged in case of removal of plant.

4. The School was established for the Indians residing in the Leupp Navajo Indian Jurisdiction. The population is approximately 2,000 and for the time being this School is considered of sufficient size to care for all the children on this particular reservation. The main office for the Leupp Indian Jurisdiction is located on the School grounds. All School matters, as well as Reservation matters, are taken care of at this office. There is also located on the grounds an agency hospital which cares for the 2,000 Indians residing on the Reservation. The School is equipped with a laundry having modern machinery, most of which was purchased during the past two years. The bakery also has modern equipment consisting of a bake oven

heated by distillate, electric dough mixer, and an electric bread and cake mixer. All quarters are in excellent shape and adequately equipped. Flamo gas has been installed in two cottages and part of the equipment is on hand to install flamo gas in the hospital.

5. A serious flood was experienced on April 6, 1929. At this time the School and Agency grounds were entirely surrounded by water and for several days it was impossible to leave these grounds. July 28th the same year another flood occurred changing the course of the river approximately two miles above the School and coming directly at it instead of following the older channel which was some distance north. This flood continued for approximately three weeks and during that time it was impossible to haul any freight to the School. During the latter part of September, or about two weeks after the School was filled to capacity, another flood occurred. The water overtopped and totally destroyed one of the dikes. This happened around midnight and by 1 a. m. in the morning all the children and employees had vacated the grounds. They camped that night on higher land about one mile from the School. After each flood it has cost the Government a considerable sum of money to repair the road running from the School grounds to Highway 66, which is the main outlet. To date, over a section of the road about one-half mile in length there have been placed

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about 2,500 loads of large rocks. It is the floods that occur during the school term period from September 1st to May 31st that make the problem most difficult. Adjacent to the school grounds is a modern sheep dipping plant. It cannot be used during flood times and has been damaged by high water.

Local Situation

6. The Little Colorado River here occupies a broad flood plain nearly two miles in width, subject to channel changes. A mile above the School, Corn Creek, with 700 square miles of drainage area, enters from the north and forms a spear point of detrital material extending into the bottom lands. Two miles below the Leupp School, Canyon Diablo enters from the south discharging at times large quantities of water, tending to cause backwater toward the School. Immediately below the mouth of Canyon Diablo the River is controlled by a constriction between bluffs to not over a thousand-foot width, tending to bottle up the floods at this point. Eighteen miles below is a rock barrier known as Grand Falls, which is the final control to any retrogression of levels in this river. Observations of the officials of the Indian Service and of the local railroad engineers indicate a gradual filling in or aggrading of the valley floor.

The evidence tends to show that the river bed has risen at least five feet in the last few years at Leupp. The obvious result is that floods that formerly passed unnoticed are now menacing the area of the School grounds, which have not been similarly raised. Gorn Creek entering from the north with a much higher gradient is cutting a deep ravine for some miles above its mouth and is depositing into the Little Colorado great quantities of silt. It is tending to force the river in a southerly direction towards the School. This has made the situation more difficult. Floods of magnitude have occurred in 1916, 1919, 1923, 1929, and 1930. During the last two floods the channel change has become acute. The improvised levees were either pierced or maintained with the utmost difficulty, using all the personnel which could be recruited for hasty service at the School.

7. The present protection system consists of a frontal levee about three feet higher than the crest of recent floods. These levees have been gradually built up by teams and draglines until the top is, in general, seven feet above the general surface of the bottom land. The first low levees thrown up have been overtopped within the last two years but as they now exist some seven feet in height they have been adequate to meet such flood conditions as have existed so far as elevations are concerned.

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These levees have been thrown up in the face of immediate and anticipated dangers. Neither their location nor their dimensions are suitable to cope with the situation that now confronts them. Behind the frontal levee the School area is partially surrounded by a secondary levee tying into a low ridge immediately north of the School. This has served in the past to keep most of the water away from the buildings when the frontal levee has failed. However, during this situation the Leupp School became an island. To reach the main land on the south required the use of a road which was submerged with a foot or more of water.

8. Riverward of the frontal levee, Kellner steel jetties have been placed. They serve as a measure of protection to the levee itself. They undoubtedly assist in deflecting the current away from the levees. Light barbed wire fences have also proved effective for deflecting the current and inducing deposit. Approximately \$60,000 has been expended in maintenance and construction of the levees and jetties to date.

Hydrology of the Little Colorado River

9. The Little Colorado River has a drainage area of about 20,000 square miles in northwest New Mexico and northeastern Arizona. On the south it drains the northerly slope of the White Mountains and on the north and east the high plateau between the San Juan and Little Colorado Rivers.

The White Mountains drainage area is of sufficient elevation to furnish considerable precipitation in the form of snow that contributes much run-off during the spring months. The plateau region gives its greatest yield of run-off during the summer season in the form of heavy thunder storms and cloudbursts.

10. The drainage area is largely composed of sandstones that disintegrate very rapidly. This, combined with the torrential character of many of the storms and the steep gradient of the stream courses, gives a run-off heavily laden with silt and fine sand. The river is characterized by a broad flood plain having a width of one to two miles between the bluffs for many miles before entering its Canyon section at Grand Falls. Through this flood plain channels meander back and forth. Where side streams enter the detrital cones often push the stream to the further side of the flood plain, such as has occurred where Corn Creek enters the Little Colorado River two miles above the Leupp Indian School. The river and its tributaries usually carry but small quantities of water or are dry except during brief flood periods. When dry the channels are shallow and poorly defined, but during floods may deepen and change alignment rapidly.

11. The Santa Fe Railway parallels the Little Colorado and its principal tributary, Rio Puerco, from

the Zuni National Forest in New Mexico, to Winslow, Arizona, a distance of approximately 120 miles. The experience of this railroad, therefore, in its many years of operation is valuable in tracing the recent history of the river. In the past ten years the flood protection work only of the Santa Fe railroad in this reach has amounted to approximately \$1,000 per mile per year. The Santa Fe engineers estimate that during the past 15 years the river bed has risen 8 feet, or approximately 6 inches per year between Adamana station and Winslow. Over-grazing and some years of unusually low rainfall has reduced protective covering and increased erosion on the watershed. The records of flood discharge of the Little Colorado River are fragmentary and poor. A table of such data with reference to these floods, as was available to the Committee, is appended.

Maps

12. Complete topographic maps of the Leupp School and of the river in that vicinity have been prepared by the Indian Irrigation Service and are appended.

Conclusions

13. The committee considers its function to be to determine what, if any, measures should be undertaken to protect the Leupp School at this time from the menace of floods. The School includes a total population of nearly 500, most of them small Indian children and women teachers, living and working in an isolated area of about 30 acres on which substantial, modern buildings valued at about \$400,000 have been located. The School is a going concern which has increased from about 70 pupils in 1921 to 400 pupils in 1931, with corresponding improvement in personnel, equipment, and organization.

14. The committee finds that the site of the School is seriously menaced by floods between April and November annually. It is located within the flood plain of the Little Colorado River, a flashy stream draining about 20,000 square miles and bearing a large percentage of alluvium or silt. Sporadic attempts in the past to give a measure of flood protection to the School have cost around \$60,000. These protective measures have prevented any disasters to date and have left some future protection to an area of about 500 acres located within a radius of about a half mile from the School. The committee is of the opinion that these measures are inadequate

to give the protection which the concentration of life and property on 30 acres of School grounds deserves.

15. It finds that an encircling levee of adequate height and cross-section can be constructed for about \$25,000 to inclose approximately 75 acres including the School grounds and that the immediate construction of such a levee is fully warranted by existing conditions.

16. The committee believes that measures to fully protect a much larger acreage from maximum floods are not economically justified at the present time, but that the existing outer lines of levees and jetties do have sufficient present value to warrant moderate expenditures for their maintenance and improvement. These outer levees have steep side slopes (about $1\frac{1}{2}:1$) and a narrow crown (about 5 feet); they have but a small freeboard over ordinary floods and will be overtopped in places by great floods unless they fail from other causes before the water rises to their tops. They are located close to existing river channels and are menaced by scour and caving at some points.

17. The existing jetties have induced considerable deposit, have reduced scour on the levees and have tended to keep the river channels away from the School area. The barbed wire fences seem here to have been about as effective as the Kellner jetties for this purpose. They are cheap

and flexible and should be used more freely in the future. Persistent efforts should be made to plant and protect brush and other vegetation adjacent to all levees to prevent scour and induce deposit.

18. Low ground exists to the south of the School which may be used as a safety channel if the deltaic cone of Corn Creek continues to force the river further to the south. This low ground may eventually become a permanent channel of the river.

19. These changes of river channel, however, can in no way endanger the School and Agency property, provided immediate and efficient means are taken to construct the encircling levee to protect the area containing the buildings and equipment (valued at \$400,000).

20. The committee has, with the assistance of the engineers of the Indian Service, laid out the proposed encircling levee on the ground. This proposed encircling levee line as shown on the detailed map in its relation to the present buildings, leaves adequate space for any reasonably probable future expansion. A cross-section and profile of the proposed levee is appended. It has ample section and height to fully protect all the valuable property and the lives of the occupants. The cost of this levee, if constructed by contract or with modern construction equipment, is estimated at \$25,000,

or 6 $\frac{1}{2}$ % of the present value of the plant. The elimination, during floods, of the drainage and sewage within this encircling levee should be provided for by a pump of about one second foot capacity with gate valves in the normal gravity outlets to be closed in emergency.

21. It is desirable for the School to maintain an avenue of communication with the outside at all times. The encircling levee as planned, while making the property secure, does not of itself provide means of egress to Winslow and other railroad points in case flood waters pass to the south. This can be provided for, however, by the construction of a graded road and pile bridge across the lowest portion of the valley to connect the School with the high ground to the south. It has been estimated that a 300-foot one-lane pile bridge and a 24-foot graded roadway averaging six feet high in the lowest part of the valley can be constructed for \$10,000. If the river should eventually take the course to the south of the School for its permanent channel, an additional length of bridge would be required and possibly the road grade would need to be raised, but the cost of these additions would not be excessive considering the value of the property involved.

22. It is desirable to raise the area between the present outer levees and the proposed encircling levee by

inducing silt deposit there from the river waters. After the encircling levee has been constructed this may be accomplished by the following method. Subdivide the area by use of barbed wire fences. Plant willows or other vegetation in the subdivisions, especially in those adjacent to both inner and outer levees, and keep livestock away from it. Provide for circulation of flood waters through this area by use of simple controlled openings in the existing levees.

23. This committee has not attempted to evaluate the intangible features which may be involved in the determination of a broad policy with reference to the future of the Leupp Indian School. It recognizes local prejudice against the permanent location of concentrated centers of life and property within leveed areas, especially when there are other suitable sites in the vicinity. It believes that in planning future building programs, consideration should be given to sites on high ground nearby.

24. The committee considers, however, that the immediate expenditure of \$50,000, or but 12 $\frac{1}{2}$ % of the present value of the existing fixed property now requiring protection, is justified to care for present needs, and should be made at once even if for broader reasons the site and property may finally be abandoned.

Recommendations

25. The committee recommends that the sum of \$50,000 be immediately allotted from any funds at present available, to be expended by the engineering branches of the Indian Service for the protection of the Leupp Indian School, by

(a) Constructing about 7200 feet of inner levee, averaging $9\frac{1}{2}$ feet high, having a 10-foot crown and 3:1 side slopes, to encircle 75 acres, including the 30 acres of School grounds, and providing suitable interior drainage and pumping, at an estimated cost of \$30,000.

(b) Constructing an approach causeway about 2400 feet long from the hills, across the valley south of the School, containing about 300 feet of single lane pile bridge and about 2100 feet of 24-foot graded roadway fill, about 6 feet high, at an estimated cost of \$10,000.

(c) Maintaining and improving the existing outer area with protective levees, dikes, and jetties, raising the 500 acres between the outer works and the encircling levees by inducing silt deposit thereon from controlled flood waters, and growing and preserving a covering of protective vegetation

thereon at an estimated cost of \$10,000.

William S. Post, Director of Irrigation
U. S. Indian Service

Porter J. Preston, Engineer
Bureau of Reclamation

John Paul Dean, 1st Lieut. Corp of Engineers
Office of the Chief of Engineers, U. S. Army

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Recorded Floods of the Little Colorado River

<u>Date</u>	<u>Place</u>	<u>Maximum Momentary Discharge</u>	<u>24-hour Average</u>	<u>Authority</u>
1905 Nov. 27	Holbrook	--	20,180	U.S.G.S. WSP 175
1906 March	Holbrook	--	3,540	U.S.G.S. WSP 211
1907 March 23	Holbrook	--	2,100	U.S.G.S. WSP 249
1916 March	Leupp	--	--	Indian Service
1919 --	Leupp	--	--	Indian Service
1923 Sept.	Winslow	50,000 ^(a)	--	Santa Fe, Est'd.
1927 June 28	Grand Falls	28,800	3,730	U.S.G.S. WSP 649
1927 June 29	Grand Falls	--	12,700	U.S.G.S. WSP 649
1929 April 6	Leupp	--	--	Indian Service
1929 July 28	Leupp	--	--	Indian Service
1929 Sept.	Leupp	-- (b)	--	Indian Service
1930 --	Leupp	--	--	Indian Service
1931 --	Leupp	--	--	Indian Service

(a) Estimate at R. R. bridge at Winslow; also reached underside of Ashurst Bridge at Leupp.

(b) Levee broke at Leupp School.

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