EXHIBIT 16

Report on Water Supply and Storage Investigations of Walker River Indian Reservation, Nevada dated December 1926

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DEPARTMENT OF THE INTERIOR
UNITED STATES INDIAN IRRIGATION SERVICE

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REPORT

ON

WATER SUPPLY AND STORAGE INVESTIGATIONS OF WALKER RIVER INDIAN RESERVATION, NEV.

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Engineer

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LETTER OF TRANSMITTAL

SUPERVISING ENGINEER,
Blackfoot, Idaho, December 29, 1926.

COMMISSIONER OF INDIAN AFFAIRS,
Department of the Interior, Washington, D. C.

DEAR SIR: Herewith is respectfully transmitted a report, with preliminary plans and estimated cost, on the proposal to construct a storage reservoir for the irrigation of Indian lands on the Walker River Indian Reservation of Nevada, as provided for by act of Congress approved June 30, 1926 (Public No. 442, 69th Cong., S. 2826).

The tests and investigations at the site which was finally selected as the only one holding out any promise of success, while not completed, have been prosecuted to the extent necessary, in my opinion, to demonstrate the feasibility of the development of storage, as well as to clearly indicate the general type of structure required. In this report, several preliminary alternative designs of dams for the storage of 22,000 acre-feet and of 30,000 acre-feet respectively, are included for comparative study, and for criticism and suggestions by the chief engineer. It is proposed, on completion of the investigations, to transmit a report supplementary to this, in which will be included the results of further investigations, and detailed plans and estimates embodying the suggestions of the chief engineer.

As it seemed necessary under the circumstances, not only to investigate the feasibility of developing storage; but also to determine the question as to whether or not storage is a necessity, this investigation has taken a wide range. As to the question of the necessity for storage however, the work has consisted only in the compilation and study of existing data and records, without any field work or surveys, as it was considered that it would be impossible within the time at our disposal, and with the funds available and under existing conditions along the river as hereinafter referred to, to make such investigations as would be necessary to determine loss of water in transit down the river channel to the Indian diversion dam. Furthermore, the investigations necessary to determine the question of feasibility of storage have, as a result of the unsatisfactory conditions encountered, been more extensive than usually required, and in consequence will practically exhaust the fund available for the work.

The surveys and investigations looking to the development of storage along the lower Walker River, and within the Indian reservation, have been made under the personal direction of Engineer W. E. Blomgren, who has also prepared and compiled the following report. The maps and drawings for the report have been prepared by Assistant Engineer H. S. Kollenborn. In the preparation of this report, we have made an effort to bring together in convenient form for reference and study, all available data in any way related to irrigation and irrigation development on the Walker River.

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SUMMARY AND CONCLUSIONS

The success of an irrigation project depends primarily upon the delivery of an adequate quantity of water to the land as, and when, needed.

Storage sufficient for assuring a dependable water supply for the entire irrigable area of Indian lands within the reservation, is believed to be feasible at what we have designated as the Rio Vista Reservoir site.

The necessity for storage development for the Indian lands, providing the Indians should be granted a water right of first priority which should be enforced by the court, is open to some question. Some assert that storage is a necessity regardless of whether or not the Indians have a water right of first priority, while others claim that, with a water right of first priority, there would be no necessity for storage. It is my personal judgment that even though the Indians should be granted a water right of first priority for the area actually cultivated up to the limit of their total irrigable area of 10,280 acres, there would be frequent occasions during average or normal years and most certainly during low-water years, when the total normal flow of the river would be insufficient to produce the required flow at their diversion point and the river bed would, not infrequently, be dry. Taking conditions as they actually are and have been for years, at least since 1898, and leaving aside any consideration of what "might have been," providing the Indians would have had a prior water right and such right had been enforced, it is plainly apparent that storage is an economic necessity, and it is a matter of surprise that the Indians have succeeded as well as they have without it.

Some idea of the excessive water loss in the river channel is indicated when it is considered that at the time above referred to, although 320 acre-feet was actually delivered in the river channel below all diversions above the Indian reservation, only 80 acre-feet finally reached the Indian diversion dam 35 miles farther downstream. It is true, of course, that this is not a fair index of the loss, as the river channel had been dry for a considerable period of time. Taken in connection with rather extensive studies and investigations of conveyance losses made by the writer under somewhat similar conditions, it is believed that it would be conservative to estimate the loss in the 35 miles of river channel between the Indian diversion and the lowest upstream diversion at 35 per cent. It is considered extremely doubtful as to whether the upstream users should be asked to stand so great a loss, if the loss can be obviated by the construction of a storage reservoir near the Indian land.

It must also be borne in mind that it is impossible to so regulate the river flow that the required quantity of water, if available, will be delivered at a diversion point so far downstream from the other diversions. There will of necessity be periods of deficient supply followed by periods of excess flow and consequent waste of water as the result of the impossibility of adjusting the stream flow to comply with a fluctuating demand at a downstream diversion point. These objectionable conditions would, of course, be removed by a storage reservoir near the diversion.

It would be a practical impossibility, as a result of existing conditions along Walker River—especially in Mason Valley—with the numerous unnecessary crude contraptions that pass for diversion weirs, but serve only to choke up, raise and widen the river channel and interfere with the regimen of the stream; the innumerable ditch diversions, many of which are unnecessary and should be prohibited or combined with others, and many of which are without even any excuse for a headgate or measuring device for controlling the water; and the present bunglesome and inefficient manner of river control and water distribution necessarily resulting from the method in practice of having three so-called water commissioners, all of whom are usually water users or officials of the Walker River irrigation district, and who are frequently unable to agree among themselves; to make such investigations as would be necessary to conclusively demonstrate the amount of water now illegally diverted and wasted, and that under usual and ordinary conditions of satisfactory diversion and stream management, would pass on down the river and be available for the lower users—the Indians. As further indicating the utter impossibility of satisfactory river control under present methods, attention should be called to the fact that during the past summer, when by mutual agreement between Indian representatives and Walker River irrigation district officials, a certain quantity of water amounting to the normal flow of the river for a specified period of time was made available for the Indians, it developed that there was disagreement between two of the water commissioners as to the handling of this water, and circumstances as well as insistent rumor seem to indicate that the water master in charge of the lower river apparently failed to make a determined effort to pass the water downstream; but allowed some to be diverted to other users, in an apparent effort "to prove that it is impossible to get water down to the Indians during the late summer because of the excessive seepage from the river channel." It is realized by all that the loss in the river channel is very great; but it is, of course, practically impossible to determine it under present conditions of control and management.

It is a matter of record that for many years, with but few exceptions, little or no water has been available for the Indians during the latter half of the irrigation season. Farming under such conditions can not be successfully carried on by anyone, and the patience, perseverance, courage and industry displayed by these people in farming their land and supporting themselves under the most disheartening conditions imaginable is almost incredible. As early as 1898, (see report of L. A. Ellis included in this report) it is reported that "there was no water after July 10, and the quantity was insufficient for about two weeks preceding that date." Reference is also made to the report of 1906, by former Chief Engineer W. H. Code. It will be noted (see general summary of irrigation data—water supply) that during the 11-year period, 1916 to 1926, inclusive, there were but two years—1922 and 1923—when there was sufficient water for irrigation during the entire season. It will also be noted from the crop valuation record for various years that the average total valuation for years of fairly sufficient water supply is approximately $60,000, while for low-water years it may be reduced to about $20,000. It is thus believed conservative to state that with an adequate water supply, the Indians' crop production would on the average be

increased by fully 50 per cent for each and every year, or approximately an increase of $20,000 per year on the average area cultivated during recent years. Moreover, it should be borne in mind, that were it not for the usual water shortage, and were it not for the fact that the superintendent of the reservation and irrigation officials have for many years consistently discouraged the improvement of new lands because of the deficiency in the water supply, it is apparent that the cultivated area would be at least twice what it now is.

Referring further to the summary of irrigation data, attention is called to the fact that there are now 3,600 acres under canal and susceptible of irrigation therefrom, at a total construction cost of $127,815, or $36 per acre for the area actually benefited. The estimated cost of the completed project with canals and laterals covering the entire irrigable area of 10,280 acres, and with the storage reservoir, is $540,000, or $53 per acre. It is apparent that land with an assured all-season water supply at $53 per acre is far more valuable and desirable than the same land with only a partial water supply at $36 per acre.

The desirability of storage is well set forth in the "Petition of the Indians" (included in this report) in the following words:

> This is most important that we must have a storage dam. It is the cry of all these Indians and it is needed to save us. Our superintendent and the supervisors of irrigation have written you of the cost and of the great benefit to us and the Government. Now we have about 1,300 acres that has cost $100 an acre, and water fails us in the early part of July, causing much loss. With the storage dam we have nearly 7,000 acres that could be irrigated and the total cost of all would be less than $50 an acre, and water would be supplied through July, August, and September, saving one or two hay crops and our gardens and pastures.
>
> Every superintendent who has been with us has urged the building of the storage dam—all say it is our salvation. We Indians have waited, but without success; our crops dry up early in summer and our stock suffers. Our Indians are afraid and discouraged, but with the dam and water sure we would take heart and our reservation and the whole valley would prosper. Most of our Indians now have to go away to work to make the money to live, which is bad for them and their children.

It is considered probable, as the Indians of the Pyramid Lake Reservation have been awarded a water right of the first priority, and as the officials of the Walker River irrigation district and all other upstream water users, who, so far as known, have ever expressed themselves on the subject, maintain that a storage reservoir will completely solve the Indians' water supply problem; that such storage reservoir will be filled every winter by the water now running to waste into Walker Lake; and even go so far as to offer to guarantee that the reservoir will be filled every season and that it will solve the difficulties; that the adverse users may not be averse to conceding by agreement or stipulation out of court a water right of first priority for the Indian lands, provided a reservoir is constructed. Since, with the reservoir constructed, a prior right would be nothing—except in name only—but what they already offer, it is not seen how they can have any objection to such a stipulation. If this plan could be worked out, would it not offer a happy solution of the entire controversy respecting water rights? Moreover, it is my judgment that the storage reservoir is a necessity under any circumstances, and it is believed that it should be constructed at the earliest practicable date. If the above suggestion is found not to appeal to the adverse water users, then it is believed that in justice to all—Indians

as well as whites—that the proposed adjudication of water rights should be brought to a conclusion as speedily as possible, so that all may know just what their rights are, so that the development and improvement of the entire Walker River Basin may go forward. It is needless to state that the present unsettled conditions respecting water rights and the unsatisfactory river management is very unsatisfactory and retards the development of the entire basin.

The necessity for storage, in order to insure a dependable all-season water supply for the Indian lands, has long been recognized, and at various times for many years past, diligent search for feasible storage sites on the lower river has been made. One site, known as the Weber site, was very thoroughly investigated some years ago, as at that time it was considered the only possibly feasible storage site, although it has many objectionable features, such as limited capacity (only 10,000 acre-feet), inaccessibility from road or railroad; unsatisfactory dam foundation; no construction materials at hand; no practicable spillway site; and the reservoir would submerge several hundred acres of Indian land, and would, moreover, be downstream from a considerable body of the irrigable land.

Every possible site has been very thoroughly examined.

The Rio Vista site, although it will require a dam of considerable length, is found to be the most feasible and practicable, and in fact, it is our deliberate judgment that it is the only feasible site along the lower Walker River. There is an excellent spillway site—good construction materials are close at hand—it is within 1 mile of the railroad; it is entirely above the Indian lands; the dam will also act as a diversion dam for part of the irrigable area; and the dam site while long, is believed to be safe and practicable.

It is our present judgment that a storage capacity of approximately 30,000 acre-feet, will be required for the Indian lands, and moreover this capacity appears to be the most economical for the proposed Rio Vista storage development. We have, however, as previously stated and as more fully explained in the report, beginning on page 46, made estimates on two alternative propositions; one for a storage of approximately 20,000 acre-feet, and the other for a storage of approximately 30,000 acre-feet.

The various dam sections so far considered, are shown on drawing No. 5 in the map container, to which reference is now made. Design No. 1 is for an earthen embankment with an upstream apron or blanket, composed of selected clay hydraulicked into place, there being a puddled cut-off core at the upstream end of the apron.

Design No. 2 is similar to design No. 1, except that instead of constructing the upstream apron or blanket entirely across the river channel, it is proposed to make use of the blue clay stratum already in place on either side of the center channel of the river, and at some distance below the river bed, by excavating the sand from the trench or crevice now existing in this natural blue clay stratum, and backfilling this crevice with selected clay so that it would form with the clay already in place, an impervious clay apron entirely across the river channel.

Design No. 3 proposes the use of sheet piling across the main channel as an alternative for the upstream impervious apron or blanket.

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Design No. 4 is patterened after the Guernsey Dam now being constructed by the Reclamation Service on the North Platte project.

It is believed that any one of these four types would be safe and satisfactory at the Rio Vista site. The additional borings and investigations now being carried on, will, in all probability, enable us to determine which of the four contemplated designs is the cheapest and most practicable, and as previously stated, this matter will be fully discussed in a supplemental report that will be submitted as soon as our investigations are completed.

RECOMMENDATIONS

In conclusion it is recommended:

1. That water rights be adjudicated at the earliest possible date.
2. That the entire river system be placed in charge of a water commissioner appointed by the Federal court, with instructions to require the installation of suitable weirs, headgates, and measuring devices by all diverters.
3. That a storage reservoir be created for the Indian land of Walker River Indian Reservation by the construction of a dam at the Rio Vista site.

Very respectfully,

C. A. Engle,
Supervising Engineer.

REPORT ON WATER SUPPLY AND STORAGE INVESTIGATIONS OF WALKER RIVER INDIAN RESERVATION, NEV.

SUMMARY OF IRRIGATION DATA

LOCATION

State: Nevada.
Counties: Mineral and Lyon.
Townships (Mount Diablo base and meridian): 12 to 15 N.
Ranges: 26 to 29 E.
Latitude (Schurz): 39°–0′ N.
Longitude (Schurz): 118° 45′ W.
Railroad: Southern Pacific (Hazen to Tonopah line).
Railroad station: Schurz (population 50).
Cities and towns near: Yerington (county seat), 22 miles west; Reno, 100 miles northwest; Tonopah, 130 miles southeast.

CHRONOLOGICAL SUMMARY

1859 (November 29): Reservation segregated by General Land Office.
1859: Indian agency established on reservation.
1859: Indians irrigate by flooding from river.
1864 (December): Reservation surveyed by Eugene Monroe.
1866: Agent Campbell and Indians build Campbell ditch.
1866: Indians first practice cultivation of crops.
1874 (March 19): Reservation formally established by Executive order.
1906: Indians allotted.

CLIMATE

Range in elevation irrigable area: 4,150–4,250.
Maximum temperature: 103°.
Minimum temperature: −17°.
Average temperature: 46°.
Average date last frost: May 1.
Average date first frost: September 15.
Average annual precipitation (Schurz) 5 inches; rainfall, 4 inches; snowfall (water content), 1 inch.

POPULATION

Indian tribe: Paiute.
Total population of reservation: 558.
Indian population of reservation: 511.

WATER SUPPLY

Source: Walker River.
Area drainage basin: 2,800 square miles.
Average elevation drainage basin: 7,000 feet.
Maximum flow at Schurz (U. S. Geological Survey, June 8, 1914): 2,625 second-feet.
Maximum flow at Wabuska (U. S. Geological Survey, July 10, 1907): 3,240 second-feet.
Minimum flow at Schurz (diversion dam):
- 1916: No water (river dry) after August 12.
- 1917–18.[1]
- 1919: No water (river dry) after July 20.
- 1920: No water (river dry) after July 30.
- 1921: Only 3 second-feet for part of April.

[1] No record; but it is the recollection of reputable witnesses, both Indian and white, that little or no water was available during August and September.

1922–23: Adequate water supply entire season.
1924: No water (river dry) after June 15.
1925: Insufficient water supply April 13 to May 6, May 19 to June 30, July 11 to 20, July 24 to August 10, August 23 to September 4.
1926: Insufficient supply after June 17 and none (river dry) after July 17, except 20 second-feet July 22 to 25, and 8 second-feet August 16 to 20.

Average flow (April to July, inclusive): 270 to 500 second-feet.[2]
Average flow (August to March, inclusive): 0 to 150 second-feet.[2]
Maximum flow, 1926 (May 18–20): 119 second-feet.[2]
Maximum annual run-off (1907): 794,425 acre-feet.[3]
Minimum annual run-off (1924): 94,780 acre-feet.[3]
Average annual run-off: 390,000 acre-feet.[3]

AGRICULTURAL CONDITIONS

Total area of reservation	acres	85, 760
Size of Indian allotments	do	20
Total number of Indians allotted		503
Total area allotted to Indians	acres	10, 060
Total irrigable area of project	do	10, 278
Canals, 50–200 second-feet capacity	miles	10
Canals, 15–50 second-feet capacity	do	8
Area now under canals	acres	3, 600
Area irrigated (1926)	do	1, 809
Area unirrigated but under canals (1926)	do	1, 791
Area irrigated by Indians, 1926	do	1, 785
Area irrigated by white owners, 1926	do	20
Area irrigated by lessees, 1926	do	4
Irrigable area Indian-owned land in project	do	9, 900
Irrigable area white-owned land in project	do	25

Irrigation season: March 15 to October 1.
Soils: Silt, loam, sandy loam, and clay loam.
Principal products: Alfalfa, wheat, potatoes, vegetables, and poultry.
Average yields:[4] Alfalfa, 3 tons per acre, value $8 to $20 per ton; wheat, 20 bushels per acre, value $1 to $3 per bushel; potatoes, 10 tons per acre, value $15 to $40 per ton.

Approximate value irrigated crops, 1922[5] on 1,436 acres, cultivated	$61, 225. 00
Crop value per acre	42. 64
Approximate value irrigated crops, 1923,[6] on 1,385 acres cultivated	40, 320. 00
Crop value per acre	29. 12
Approximate value irrigated crops, 1924,[7] on 1,831 acres cultivated	24, 710. 00
Crop value per acre	13. 50
Approximate value irrigated crops, 1925,[8] on 1,229 acres cultivated	57, 345. 00
Crop value per acre	46. 66

FINANCIAL DATA

Total irrigable area contemplated project	acres	10, 280
Total estimated cost contemplated project, including reservoir and canal system		$540, 000. 00
Total estimated cost per acre		53. 00
Total construction cost to June 30, 1926		127, 815. 12
Total construction cost to date per acre now under canals		36. 00
Average value land without irrigation (acre)		5. 00
Average value land when irrigated		150. 00
Average cost of preparing land for irrigation		30. 00

[2] These records from U. S. Geological Survey measurements at the Wabuska station, just above the west boundary of the reservation and above project diversions.
[3] From records of U. S. Geological Survey gauging stations on the upper river and above nearly all diversions and represents the total river run-off.
[4] It is estimated that yields would be increased by 50 per cent if a full season's water supply were available.
[5] Sufficient water supply during season.
[6] Sufficient water supply but damaging frost on June 13 reduced crop yield 50 per cent.
[7] No water after June 15.
[8] Fairly sufficient water supply during 1925.

WALKER RIVER BASIN STATISTICS

Walker River Basin, total area irrigated in 1902 acres	54, 055
Total investment in irrigation works in 1902	$179, 995. 00
Total investment in irrigation works per acre	$3. 33
Total area irrigated in 1920 acres	113, 364
Total investment in irrigation works in 1920	$1, 661, 484. 00
Total investment in irrigation works in 1920, per acre	$13. 30
(Above figures from tabulated statistics in 1920 census.)	
Estimated total investment in irrigation works in 1926	2, 600, 000. 00
Estimated per acre investment in irrigation works in 1926	15. 75
Investment of United States in irrigation works on Walker River Reservation in 1926	130, 000. 00
Investment of United States per acre under canal	36. 00
1925 crop value of Walker River irrigation district (approximately)[9]	2, 000, 000. 00
1925 crop value of Walker irrigation district per acre, approximately [9]	28. 57
1925 crop value of Indians	56, 615. 00
1925 crop value of Indians, per acre	46. 85

WALKER RIVER INDIAN RESERVATION

The Walker River Indian Reservation in western Nevada, was established November 29, 1859, when the Commissioner of Indian Affairs directed the Commissioner of the General Land Office to segregate the area included in the reservation from the public domain. The survey of reservation boundaries was completed in December, 1864, by Eugene Monroe. The reservation was formally established by the Executive order of President Grant of March 19, 1874. A portion of the reservation was restored to the public domain in 1906 to permit exploration and mineral development. The boundaries of the reservation were then changed to include only the lands in the Walker Lake Valley, comprising an area of 85,760 acres.

WALKER RIVER IRRIGATION PROJECT

DESCRIPTION

The Walker River project on the Walker River Reservation, is located in townships 12 to 15 north, ranges 26 to 29 east, Mount Diablo meridian, Mineral County, Nev. The project comprises an area of approximately 10,280 acres of river bottom lands, 10,060 acres of which have been allotted to the Paiute Indians in 20-acre irrigable allotments. The land lies along both sides of the Walker River and varies in width from one-half to 4 miles, extending in a northwesterly direction from Walker Lake for a distance of approximately 24 miles up the Walker River. The soil varies in character from a fine river silt, silty and clay loams, to sandy loams and coarse sands. Contrary to the opinion of irrigation engineers in the early reports on the project, the soil has proven very fertile, and with ample water for irrigation produces excellent crops of potatoes, corn, and alfalfa. The Indians of this reservation exhibit considerable inclination toward farming. They are quite industrious and those who, because of the successive years of water shortage and consequent lack of water for the irrigation of their lands, have been unable to farm

[9] From statement of Congressman S. S. Arentz in Congressional Record.

their allotments, have moved to Mason Valley where they are employed as farm hands and laborers by the white farmers.

The small amount of farm produce that is grown by the Indians is marketed at excellent prices in near-by markets. The Indians enjoy free freight privileges on the Reno-Tonopah branch of the Southern Pacific Railroad passing through the reservation, and the mining camps to the south can readily absorb all the products of the reservation.

At the present time it is stated that an arsenal and ammunition depot for the Army and Navy Departments may be located near Walker Lake, affording employment for many workers. The establishment of this work in the immediate vicinity of the reservation would create an added demand for the vegetable and poultry products of the Indians.

There are two separate areas of allotted irrigable lands, one of approximately 3,000 acres, known as the Campbell, or upper, valley, and the lower, or Walker Lake, Valley, containing an area of some 7,200 acres, which is within the present irrigation project, and extending to the shores of Walker Lake. Early irrigation farming was begun in 1866 in the upper valley, where the first reservation headquarters were established. Due to the difficulty in maintaining river diversions and ditches, irrigation in this valley was abandoned and agency activities moved to the head of the lower valley about 10 miles down the river. Later the agency headquarters were established at the present location of Schurz, Nev., about 3½ miles up the river from Walker Lake. Development and irrigation construction by the United States Government has been confined to the lower valley where the canal and lateral system forming the present project is approximately 51 per cent completed, involving an expenditure to date of about $130,000. The allotted lands in the upper valley, having no diversion works and ditches, are still vacant and undeveloped.

HISTORY

The first irrigation work was the construction of a small river diversion and several thousand feet of ditch in 1866 in the upper valley by Farmer H. A. Thomas, under Agent Frank Campbell. As heretofore mentioned, floods in the river made it difficult to maintain diversion works, and irrigation in this area was later abandoned in favor or the lower valley. Sometime during 1871 or 1872 the reservation headquarters were moved to section 15, township 13 north, range 28 east, and diversions and ditches, irrigation and cultivation of lands in the lower valley begun. This has continued with small increases in area up to the present time. Farming on this reservation has always been carried on under serious handicaps. The variable character of the river flow from heavy floods in June to practically nothing during July and August, in some years has made diversion difficult and costly, and farming hazardous in the late summer because of insufficient water. The problem of inducing nomadic Indians to become farmers and adopt the customs of civilization was questionable, and early funds available for irrigation work were meager and inadequate.

Officials of the bureau apparently were skeptical of irrigated farming possibilities on the reservation. As settlement continued and

irrigation expanded in the upper valleys of the Walker River, the water supply available for the reservation became less each year, and by the time the irrigation diversion of the Bureau of Indian Affairs was organized, it was doubtful to the early investigators whether there was a dependable water supply for the irrigation of reservation lands.

With the organization of the irrigation division of the bureau in 1900, with Mr. W. H. Code as chief engineer, surveys and investigations were made with a view of providing for a definite plan of development and systematic irrigation construction. Mr. George Butler, superintendent of irrigation at large, first reported on the irrigation possibilities in 1901. In accordance with the recommendations of Mr. Butler, funds were provided for a timber diversion dam, constructed in 1902 by Engineer W. W. Coleman. Nothing further was done until 1905, when funds were provided for further surveys and ditch construction. Surveys and ditch construction on a small scale were carried on for several years under Superintendent of Irrigation J. R. Meskimmons, Engineers Fitzpatrick, Hulbert, E. E. Jones, F. E. Weber, and J. A. Beemer; most of the project construction work being done by Engineer Jones in 1908 and 1909. Because of the uncertainty of the water supply, irrigation construction was never completed. Assistant Engineer Weber, in 1915, made preliminary surveys and tentative plans for a reservoir and storage dam under the direction of Superintendent of Irrigation H. W. Dietz. Further surveys, investigations, and estimates were made by Engineer J. A. Beemer in 1918 and 1920, and submitted with the reports of Supervising Engineer Dietz.

In 1924 and 1925 surveys were made to obtain irrigation data for use in the suit instituted for the purpose of adjudicating the water rights of the Indians, but to date no decision has been rendered. Further surveys were made of possible reservoir sites in conjunction with the adjudication surveys in 1924 and 1925, but funds were insufficient to carry on detail investigations and studies.

An act of Congress approved June 30, 1926 (Public, No. 422, 69th Cong., S. 2826) authorizing investigations to determine the feasibility of the construction of an irrigation dam on the Walker River, Nev., reads as follows:

> *Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* For reconnaissance work in Schurz Canyon, on the Walker River, State of Nevada, to determine to what extent the water supply of the river can be augmented and conserved by the impounding of its said waters, and to determine if there is a feasible reservoir site or sites available for the storage of such waters, and for securing information concerning the feasibility of the construction of the necessary dam or dams and appurtenant structures, and for the purpose of determining the amount necessary for the purchase and acquisition of necessary lands and rights of way in connection with the construction of said dam or dams and appurtenant structures, which are proposed in order to provide water for irrigation purposes, the sum of $10,000, or so much thereof as may be necessary, is hereby authorized to be appropriated. Said sum or any part thereof that may be expended for this work, shall be reimbursable if and when the project referred to is adopted for construction by the United States or other agency and in accordance with the terms of such adoption of the project.

The attitude and patience of the Indians on this reservation is to be commended. They have shown great forbearance in attempting to cultivate their lands under the variable and uncertain water supply conditions of the past. The location and favorable markets for

farm produce, combined with soil fertility and climatic conditions, make it possible to realize substantial profits from irrigated farming. These Indians have demonstrated their ability in this industry, and with an adequate supply guaranteed would undoubtedly make rapid progress toward the full development of the project.

WATER SUPPLY

DESCRIPTION OF WALKER RIVER BASIN

The Walker River, which is the only source of water supply for the Walker River Reservation, rises on the eastern slopes of the Sierra Nevada Mountains, in two main branches, the East and West Walker, which are separated by the Sweetwater Range. The upper portion of the basin lies in California and the lower portion in Nevada.

East Walker River also receives drainage from the eastern slope of the Sweetwater Range and the western slope of the Wassuk Range in addition to that of the Sierras. Its valleys are narrow, and the surrounding areas are rugged and broken.

West Walker River parallels the main Sierra Range, receiving also the drainage from the western slope of the Sweetwater Range. It joins the East Walker to form the Walker River in the southern part of Mason Valley, Nev.

Walker River flows from the union of the two branches which form it northward through Mason Valley in a tortuous course to near the town of Wabuska, where it turns abruptly eastward and then southeast, finally discharging into Walker Lake. This river system from the junction of Green and Virginia Creeks, which unite to form East Walker, to Walker Lake is 120 miles long, in which distance the waters fall 2,400 feet. From the junction of the East and West Walker to Walker Lake the river fall is 400 feet in 50 miles. West Walker is the more important branch, supplying nearly twice as much water as it does the East branch.

The basin contains six important valleys—Antelope and Smith Valleys on the West Walker, Bridgeport and Sweetwater Valleys on East Walker, and Mason and Walker Lake Valleys on the main stream.

There is only one large valley on the East Walker. It is located at the headwaters of the stream and is known as Big Meadows or Bridgeport Valley. Below this valley the river enters a comparatively narrow canyon, which confines it to its junction with the West Walker. Along this course, however, there are alluvial plains of limited extent that are watered from the river. The nearest approach to an open valley is at the junction of Sweetwater Creek with the East Walker, where a considerable area is irrigated from both streams.

Mason Valley, the largest valley in the basin, is watered from the East Walker, West Walker, and the Main Walker River. The two branches unite in the southern part of the valley, after emerging from their respective canyons. Below Mason Valley, Walker River enters a broad canyon through the northern end of the Walker River Range. The country gradually opens out into a rolling

valley, embraced in the Walker River Indian Reservation, or often called, Walker Lake Valley.

Mason Valley is about 30 miles in length, and in its widest part is 12 miles in width. It is the largest area of the Walker River Irrigation District, which embraces practically all of the irrigable lands in the Walker River Basin in Nevada, except those of Walker Lake Valley included in the reservation; 45,000 acres are said to be irrigated by the district in the valley. The major portion of the irrigated lands lie on the east side of the river. In the southern part these lands are fairly well cultivated, being owned in tracts from 80 to 1,000 acres. The northern portion, however, is largely owned by the Antelope Valley Land & Cattle Co., successors to the Pacific Livestock Co. (Miller & Lux) and other large cattle men. Water has been extravagantly used to produce pasture and wild hay with comparatively little cultivation. The inevitable result is that a large part of the land is water-logged and impregnated with alkali. Many large areas that in the early development of the valley were excellent alfalfa fields, have now become worthless salt grass pastures, upon which water is still being wantonly wasted in the early summer. Extensive drainage will have to be resorted to in order to reclaim them. The elevation of the valley varies from 4,500 feet in the southern part, to 4,300 in the northern part, the northern 18 miles having a fall of only 100 feet. The banks of the river are low and ditches are taken out very frequently all along this course. The majority of the diversions are crude devices of brush and rock being rebuilt each year; many of the ditches diverting at these points have no head gates or means of control—the excess water diverted from the river being allowed to overflow into adjoining sloughs and some of it returning to the river channel, but a considerable portion being wasted by seepage and evaporation. Other head gates are crudely built timber structures, regulation being effected by placing loose stop planks or boards in these with no means of locking to insure against tampering. As a consequence, water distribution and river regulation has been unsatisfactory and unjust to users on the lower section of the river, who, in the late season, during periods of low normal river flow have been deprived of water, or their irrigation handicapped by constantly fluctuating flows.

In Smith Valley, next above Mason Valley on the West Walker, there is under irrigation approximately 18,000 acres, including scattered areas adjacent to Desert Creek on the south. The elevations range from 4,550 to 4,900. The lands on the north side lie in benches 10 to 50 feet higher than the river. The lands to the south of the river have a gentle slope toward the river, and are extensively irrigated and cultivated. As a general rule, the lands of Smith Valley are better farmed, although there are many large holdings devoted to the raising of livestock. Nearly half of the area on the north side of the river drains to the extreme north into a low depression known as Alkali Flat which is lower than the river opposite. Excessive use and waste of water has partially filled this basin and water-logged considerable areas in this tract. Some drainage work is now being done by several of the larger landowners. River diversions and head gates in this valley are better constructed and of a more modern type than those in the lower valleys, and much better river regulation and water distribution is obtained.

Antelope Valley on the West Walker lies at the foot of the Sierra Range and ranges in elevation from 4,970 to 5,450. It is reported that approximately 20,000 acres, including lands in pasture and wild hay, are irrigated in this valley. Practically all of the land is owned by the Antelope Valley Land & Cattle Co., successors to T. B. Rickey. Lands bordering the river lie close to the water and are frequently subirrigated from the stream to produce natural meadow.

Walker Lake, into which the river flows, is one of the most attractive of Nevada lakes. It is one of the remains of that glacial lake, Lahontan, which occupied the northwestern portion of Nevada during the Quarternary period. It is approximately 26 miles long and 5 miles wide, with an area of 95 square miles. Its depth is generally over 225 feet, becoming deeper near the western shore, which is bordered by the rugged Wassuk and Walker River Ranges. The waters are saline, as in all lakes of the interior basin, but not too salty for the sustenance of fish. Stock will also drink the water when no other is to be had. The lake level is gradually becoming lower each year, and it is stated that the lake level is now approximately 20 feet lower than it was 30 years ago. The lake level in 1926 was fully 6 feet lower than in 1923, due to the abnormally low stream discharge of the past three years.

The total drainage area of the river above the reservation is 2,550 square miles. The greater part of the water shed is rugged, steep, and generally barren with sparse areas of scrub timber. The snowfall is comparatively heavy in the higher Sierras, but due to the watershed conditions the greater part of the run-off occurs in May and June, and without storage the river can not furnish all the irrigable area a dependable water supply for late season irrigation. The run-off is extremely variable, the maximum annual run-off being approximately 800,000 acre-feet, and the minimum 93,000 acre-feet.

IRRIGABLE LANDS IN WALKER RIVER BASIN

The areas now irrigated lie in the valleys above mentioned. In these valleys the lands have a gradual slope downstream, but with general surface drainage toward the river. They are alluvial plains through which the river meanders in a tortuous course, often changing its channel and thus leaving bayous that in the course of many years gradually silt up.

The valleys on the West Walker are Antelope Valley, Smith Valley, and the southern end of Mason Valley. Above Antelope Valley the river is in a rugged canyon, in which the waters fall 130 feet per mile. Below Antelope Valley the River is confined in Hoye Canyon, afterwards opening out into Smith Valley. Below Smith Valley the river again enters a defile called Hudson Canyon to emerge into Mason Valley, where it joins its waters with those of the East Branch.

The lands now irrigated by the Antelope Land & Cattle Co. are now practically ruined from alkali, due to the excessive use of water. Large quantities of water are run over the meadows every year to insure a growth of wild hay. Much of the area was flooded to kill sagebrush and start a growth of grasses for pasturing. It is stated that much of this excessive use and waste of water was done in order to utilize in some manner the water obtained through a decision of

the United States court in the case of Pacific Livestock Co. *v.* T. B. Rickey et al., resulting in court decree No. 731, under which the Walker River is now operated. These pastures have been copiously irrigated, with a result that much of the land is water-logged and impregnated with alkali.

A depression to the north and lower end of the valley, contiguous to the California State line, formerly known as Alkali Lake, has been utilized as a storage reservoir, now designated as Topaz Reservoir, by the Walker River irrigation district. The storage of 50,500 acre-feet was developed by the construction of a diversion canal from the West Walker River to Topaz Lake, and an outlet tunnel built through a natural dike or hill to the northeast. Water is then conducted by a constructed canal back to the river, as released from the reservoir.

Bridgeport Valley, or "Big Meadows," lies wholly in California at the source of the East Walker River, and ranges in elevation from 6,500 to 6,700 feet. It embraces about 25,000 acres of land, of which 20,000 are said to be irrigated. The larger part of the land is owned by successors to T. B. Rickey, and the same careless methods of irrigation have been followed here as were noted for the Antelope Valley, with the result that a considerable area is water-logged. There is little or no cultivation of lands, which are irrigated principally for pasture.

The valley is fed by a number of creeks, which debouch from the high Sierra slopes into winding channels upon the valley floor. The East Walker is formed by the union of Virginia and Green Creeks. Other creeks flowing into the valley are Summers, Robinson, Buckeye, and Swager Creeks.

Some storage has been developed by private interests—Messrs. Hunnewill, Day, Simpson, and others—by controlling Twin Lakes on upper Robinson Creek. The water surface of lakes are 7,076 and 7,096, respectively.

The Walker River irrigation district during 1925 constructed the Bridgeport Dam, an earthfill structure about 60 feet high, containing approximately 130,000 cubic yards of fill at a cost of approximately $435,400, or $10.37 per acre-foot of storage, which created the Bridgeport Reservoir with a storage capacity of 42,000 acre-feet.

The Topaz Reservoir on the West Walker, heretofore mentioned, involving the construction of a diversion dam and inlet channel to, and a tunnel and outlet works from Topaz Lake (formerly Alkali Lake), created a storage of 50,500 acre-feet, making the total storage available for district lands 92,500 acre-feet. The total cost of the Topaz Reservoir was $423,500, or $8.40 per acre-foot.

The total irrigable area in the district is approximately 164,000 acres, of which 85,000 acres are said to be under irrigation or partial irrigation. In addition, there are approximately 38,000 acres in California and 10,000 acres of irrigable lands on the Walker River Reservation, making a total of 208,000 acres of irrigable lands on the river. With a gross duty of water of 3 acre-feet per acre per year, the duty adopted by the engineers in reporting on water supply for the district which is probably too conservative and not attained in diversion, 624,000 acre-feet annually will be required. The following tables indicate that the safe annual supply or the average annual run-off of the 23-year period, from 1903 to 1926, is 387,422 acre-feet. It is apparent that a higher duty of water must be obtained or hold-

over storage provided. It is also evident that storage is required for nearly all lands for the months of August and September as the average normal flow for these months will only supply approximately 24,000 acres, on the basis of .013 second-foot per acre.

A total area of approximately 107,500 acres is now said to be under irrigation on the Walker River as follows:

	Acres
Antelope Valley, West Walker River (Calif.)	15, 000
Smith Valley, West Walker (Nev.)	18, 000
Mason Valley, Main Walker (Nev.)	45, 100
Bridgeport Valley, East Walker (Calif.)	20, 000
Sweetwater and Smaller Valleys, East Walker (Nev.)	7, 500
Walker Lake Valley (reservation), Main Walker (Nev.)	1, 900

With a duty of water of 3 acre-feet per acre, these lands will require an annual supply of 322,500 acre-feet, plus transmission and evaporation losses, probably not less than 25 per cent or approximately 403,000 acre-feet at river diversion. On a continuous flow basis, it will require 417,600 acre-feet to supply all rights of 1,162 second-feet under decree No. 731 for 83,613 acres, from April 1 to October 1.

From the foregoing, it is plainly apparent that certain rights must be established for the reservation with the last and lowest diversion on the river, and that more storage should be developed by all interests along the river to further conserve the run-off now allowed to waste during May and June each year.

In his report of June, 1915, to the United States Reclamation Service, on the proposed Walker Basin development, Mr. J. C. Stevens estimates that 241,000 feet of storage are required for 132,000 acres of land, excluding the Bridgeport and upper East Walker Valleys, as follows:

[From Report of U. S Reclamation Service by J. C. Stevens, engineer, June, 1915]

LANDS FOR WHICH THERE IS AN AVAILABLE WATER SUPPLY

The total area of land that can be irrigated by providing storage of 196,000 acre-feet on West Walker River, and of 45,000 acre-feet on East Walker, or a total storage of 241,000 acre-feet, is 132,600 acres distributed as follows:

	Old land with water rights	New lands	Total
	Acres	*Acres*	*Acres*
Antelope Valley	14, 200		14, 200
Smith Valley	8, 590	25, 000	33, 590
Mason Valley	43, 130	31, 000	74, 130
Walker Lake Valley	1, 910	8, 790	10, 700
Total	67, 830	64, 790	132, 620

Mr. Stevens' figures are based upon the following assumptions—net duty of water at land, 2 acre-feet per acre, or a gross duty of 3 acre-feet at river diversion, as follows:

	Per cent of total	Acre-feet per acre
April	10	0. 30
May	18	. 54
June	22	. 66
July	22	. 66
August	20	. 60
September	8	. 24
Total	100	3. 00

Return flows to river

	Per cent of diversions
Antelope Valley	50
Smith Valley	35
Mason Valley (West Walker)	25
Mason Valley (East and Main Walker)	15

Summary of lands under proposed irrigation works

	Irrigated, 1905	New lands	Total
	Acres	*Acres*	*Acres*
Smith Valley, west canal	1,040	15,960	17,000
Smith Valley, east canal	3,720	13,280	17,000
Mason Valley, west canal	4,760	19,240	24,000
Mason Valley, east canal	16,000	25,000	41,000
Walker Lake Valley (reservation)	900	9,800	10,700
Total	26,420	83,280	109,700

[Senate Report No. 810, Sixty-ninth Congress, first session]

The Senate Committee on Irrigation and Reclamation, to whom was referred the amendment to the bill (S. 2826) for the construction of an irrigation dam on Walker River, Nev., and for other purposes, having considered the same, report the amendment favorably in the following amended form and recommend that it do pass.

Strike out all after the enacting clause and insert the following:

"For reconnaissance work in Schurz Canyon, on the Walker River, State of Nevada, to determine to what extent the water supply of the river can be augmented and conserved by the impounding of its said waters, and to determine if there is a feasible reservoir site, or sites, available for the storage of such waters and for securing information concerning the feasibility of the construction of the necessary dam, or dams, and appurtenant structures, and for the purpose of determining the amount necessary for the purchase and acquisition of necessary lands and rights of way in connection with the construction of said dam or dams and appurtenant structures, which are proposed in order to provide water for the irrigation of lands allotted to Indians on the Walker River Indian Reservation, Nevada. For the above-named purposes an appropriation of $10,000 is hereby authorized to be used for the reconnaissance work herein referred to.

"SEC. 2. That upon the passage of this act all proceedings, legal or otherwise, on the part of the Federal Government affecting the water rights of water users of said river shall forthwith be suspended, and if and when the project be found feasible shall be dismissed."

There are made part of this report the following letters from Mr. E. C. Finney, First Assistant Secretary, Department of the Interior, dated May 8, 1926. Mr. Finney's letter to the Director of the Bureau of the Budget, dated April 30, 1926, refers to the original bill. Since then the proposed amendments have brought the provisions within the recommendations of the Interior Department, as outlined in the last two paragraphs of said letter to the Director of the Budget.

DEPARTMENT OF THE INTERIOR,
Washington, May 8, 1926.

Hon. TASKER L. ODDIE,
United States Senate.

MY DEAR SENATOR ODDIE: In reply to your request of even date, I transmit herewith copy of letter to the Director of the Bureau of the Budget, dated April 30, 1926, recommending an appropriation for investigation of water supply and feasibility of reservoir sites on the Walker River, Nev.

Very truly yours,

E. C. FINNEY,
First Assistant Secretary.

DEPARTMENT OF THE INTERIOR,
Washington, April 30, 1926.

Hon. H. M. LORD,
Director of the Bureau of the Budget, Washington, D. C.

MY DEAR GENERAL LORD: On February 26, 1926, this department, with your concurrence, submitted an adverse report on S. 2826, a bill which proposes to authorize the expenditure of $175,000 for construction of a dam on the Walker River, State of Nevada, to provide water for the irrigation of lands allotted to Indians.

Owing to the increased irrigation activities along the Walker River above the Indian Reservation, and particularly as a result of irrigation projects constructed by the Walker River irrigation district, the supply of water available for Indian lands has been greatly diminished.

Suit was instituted by the Attorney General of the United States for the protection of the water rights of the Indians of the Walker River Indian Reservation, which suit is now pending in the United States District Court in and for Nevada.

It is claimed that there are one or more additional available reservoir sites upon the river and a sufficient amount of water, including flood waters and return flow, to provide for the irrigation of all of the lands involved, including those of the district and the irrigable lands of the Indian reservation.

The department is of opinion that the expenditure of a small amount in investigating the possible water supply and the feasibility of a reservoir site, or sites, to impound same is justifiable.

I have the honor to transmit herewith supplemental estimate which proposes the expenditure of not exceeding $10,000 for such investigation, and to recommend that same receive your approval.

Very truly yours,

E. C. FINNEY,
First Assistant Secretary and Budget Officer.

[S. 2826, Sixty-ninth Congress, first session]

AN ACT For the construction of an irrigation dam on Walker River, Nevada

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, For reconnaissance work in Schurz Canyon, on the Walker River, State of Nevada, to determine to what extent the water supply of the river can be augmented and conserved by the impounding of its said waters, and to determine if there is a feasible reservoir site or sites available for the storage of such waters, and for securing information concerning the feasibility of the construction of the necessary dam or dams and appurtenant structures, and for the purpose of determining the amount necessary for the purchase and acquisition of necessary lands and rights of way in connection with the construction of said dam or dams and appurtenant structures, which are proposed in order to provide water for the irrigation of lands allotted to Indians on the Walker River Indian Reservation, Nevada. For the above-named purposes an appropriation of $10,000 is hereby authorized to be used for the reconnaissance work herein referred to.

SEC. 2. That upon the passage of this act all proceedings, legal or otherwise, on the part of the Federal Government affecting the water rights of water users of said river shall forthwith be suspended, and if and when the project be found feasible shall be dismissed: *Provided,* That arrangements are made with the Walker River irrigation district whereby a supply of water is agreed to be delivered to the one thousand eight hundred and sixty acres now being cultivated by said Indians upon the said reservation.

TABLE I.—*East Walker River annual run-off by months in acre-feet*

[From records of U. S. Geological Survey, U. S. Reclamation Service, and Walker River irrigation district]

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1903 [1]	7,010	5,610	12,730	7,875	7,750	22,100	14,890	2,640	3,890	5,140	6,190	6,270	102,095
1904 [1]	4,230	9,430	13,160	9,005	16,550	1,320	33,090	22,870	12,760	19,410	13,450	9,040	164,315
1905 [1]	5,940	7,800	8,060	6,000	6,980	16,350	11,470	4,560	4,200	4,200	4,500	4,500	84,560
1906 [1]	7,810	6,890	12,900	14,275	31,550	47,790	65,630	33,410	11,670	6,740	4,500	11,300	254,465
1907 [1]	10,300	13,500	22,400	19,275	38,450	53,090	67,630	36,110	15,870	11,000	9,340	6,460	303,425
1908 [1]	9,350	7,760	15,900	10,876	7,230	10,380	11,820	7,410	4,570	5,400	6,000	6,000	102,695
1909 [2]	[2] 4,000	9,000	12,000	8,000	12,000	30,000	27,000	20,000	10,000	15,000	10,000	[2] 8,000	165,000
1910 [3]	11,830	15,199	24,101	15,412	20,526	25,644	21,295	8,828	9,534	9,534	6,654	5,360	173,917
1911 [3]	5,370	9,330	13,300	37,000	35,330	80,490	74,930	13,960	7,610	9,060	7,020	3,940	297,340
1912 [3]	4,940	5,230	5,050	4,080	11,460	22,480	17,530	5,570	4,970	4,120	6,000	3,900	95,330
1913 [3]	3,500	4,500	5,000	3,309	11,870	22,980	16,030	7,700	6,420	4,490	6,210	3,970	95,979
1914 [3]	18,200	13,700	18,800	32,000	56,370	61,790	51,730	19,700	7,640	7,070	6,430	4,940	298,370
1915 [3]	5,250	5,660	7,930	13,300	15,770	25,570	25,330	4,020	4,710	3,680	3,390	5,490	122,100
1916 [3]	5,000	8,000	17,000	32,800	36,870	47,990	36,530	12,500	10,100	15,920	10,300	7,260	240,270
1917 [3]	5,030	7,500	11,100	26,070	24,950	45,590	29,930	9,910	8,570	8,400	7,000	4,800	188,850
1918 [2]	[2] 6,000	6,000	10,000	7,000	9,000	30,000	18,000	6,000	4,400	4,800	4,800	[2] 5,000	111,000
1919 [2]	[2] 5,000	6,000	9,000	6,000	9,000	25,000	18,000	6,000	4,000	4,000	5,000	[2] 6,000	103,000
1920 [4]	6,000	6,000	12,500	12,000	11,000	24,000	15,000	5,770	5,180	5,890	5,150	7,800	116,290
1921 [4]	6,800	7,000	10,000	6,900	9,610	30,000	19,220	6,500	4,300	4,900	4,800	5,000	115,030
1922 [4]	3,000	2,970	4,305	17,260	28,190	48,805	29,525	10,980	4,230	4,980	6,235	7,305	167,785
1923 [4]	6,302	7,202	11,614	6,610	15,574	18,306	19,530	8,272	7,530	6,100	5,300	4,900	117,240
1924 [4]	5,440	3,780	4,030	3,400	4,660	2,140	1,250	818	1,140	1,616	2,200	2,300	32,774
1925 [4]	2,700	3,500	4,038	6,275	9,190	17,830	19,578	11,050	6,000	3,500	4,780	4,500	92,941
Mean	6,478	7,459	11,518	13,249	18,690	30,941	28,041	11,504	6,926	7,172	6,315	5,828	154,120
Mean flow (second-feet)	105	133	187	223	304	520	456	187	116	117	106	95	

[1] Ross Ranch station.
[2] Estimated.
[3] Mason station, 2½ miles above junction of West Walker.
[4] Bridgeport station, below Bridgeport Dam.

Bridgeport Reservoir completed in April, 1925; capacity, 42,000 acre-feet.

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TABLE II.—*West Walker River, at Coleville, Calif., annual run-off by months in acre-feet*

[From records of U. S. Geological Survey; U. S. Reclamation Service; Stone & Webster; Walker River Irrigation District]

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1903	4,240	4,380	6,460	14,640	54,600	89,970	24,720	8,790	4,480	4,120	4,580	4,120	225,080
1904	3,860	7,335	11,500	22,850	56,510	70,690	48,870	20,410	10,240	18,380	7,440	5,270	283,355
1905	4,630	4,780	8,180	15,830	34,310	47,070	20,540	6,580	3,810	3,650	3,460	3,810	156,650
1906	4,770	4,330	6,460	21,400	70,100	122,000	134,000	31,100	11,400	6,060	5,690	5,810	423,120
1907	5,880	7,330	23,400	31,100	70,700	117,000	152,000	42,100	16,000	10,100	8,330	7,320	491,260
1908	7,130	5,870	10,100	20,000	33,700	41,200	28,300	7,500	3,900	4,800	4,800	4,800	172,100
1909	4,200	4,200	4,660	19,200	53,500	96,500	51,000	14,450	5,150	4,550	7,200	6,760	271,370
1910	5,350	4,710	14,950	37,800	63,500	59,000	23,400	7,500	7,550	4,200	4,050	3,600	235,610
1911	5,790	7,650	8,660	28,210	52,100	117,000	89,500	22,000	7,550	4,610	4,580	3,920	351,570
1912	3,500	3,420	3,930	4,400	24,800	59,500	18,300	5,540	3,570	3,200	3,510	3,080	136,750
1913	2,650	2,780	4,000	8,550	30,600	41,000	16,600	10,020	6,300	3,420	3,400	2,960	132,280
1914	15,000	9,000	12,000	45,000	72,000	96,000	40,000	26,000	13,000	5,000	5,000	3,000	341,000
1915	3,500	3,200	5,800	17,000	33,000	66,000	45,700	9,900	3,990	3,570	2,860	2,770	197,290
1916	4,920	5,070	12,400	28,200	50,800	71,400	45,700	15,600	6,370	9,780	6,130	4,240	260,610
1917	2,150	4,110	5,720	20,400	41,000	90,400	51,600	13,500	5,840	4,460	4,110	2,710	246,000
1918	3,300	2,770	4,950	20,100	36,800	76,800	22,300	6,760	6,780	11,200	6,720	6,460	204,940
1919	5,500	5,220	6,640	21,200	64,000	36,200	12,500	4,990	3,120	3,870	3,560	3,720	170,520
1920	3,910	3,700	4,770	9,400	58,800	69,000	16,300	6,210	4,470	4,500	4,900	4,200	190,160
1921	4,000	4,000	4,800	14,000	48,000	82,200	34,000	7,800	4,800	4,000	4,200	3,600	215,400
1922	3,320	2,775	4,000	8,710	67,175	107,160	48,450	11,495	5,085	4,686	4,380	4,912	272,148
1923	4,426	5,038	7,388	14,944	52,782	48,350	46,372	10,700	7,530	5,580	3,270	2,740	209,120
1924	2,580	2,700	2,900	9,740	28,800	6,310	1,650	1,070	925	1,570	2,190	1,940	62,375
1925	2,340	3,230	6,820	18,400	58,500	58,200	33,800	8,920	3,610	3,610	3,170	2,880	203,480
Mean	4,650	4,678	7,847	19,612	50,264	72,563	43,722	12,997	6,324	5,605	4,675	4,114	237,052
Mean flow (second-feet)	76	83	128	330	817	1,219	711	211	106	91	79	67	

TOTAL WALKER RIVER RUN-OFF, COMBINED EAST AND WEST WALKER RIVERS

Mean acre-feet	11,128	12,137	19,365	32,861	68,954	103,504	71,763	24,500	13,250	12,777	10,990	9,942	391,167
Mean second-feet	181	216	315	553	1,121	1,739	1,167	398	222	208	185	162	

Topaz Reservoir completed in 1921; storage begun in 1922; capacity, 50,500 acre-feet.

1199006511

TABLE III.—*Water supply summaries, Walker River—combined east and west Walker River run-offs*

Month	Mean monthly run-off in acre-feet				Mean flow in second-feet		Decree No. 731, effective priorities
	Maximum, 1907		Minimum, 1924		23-year mean		
	Run-off (acre-feet)	Mean (second-feet)	Run-off (acre-feet)	Mean (second-feet)	Run-off (acre-feet)	Flow (second-feet)	
January	16,180	263	8,020	130	11,128	181	1862 and earlier.
February	20,830	375	6,480	113	12,137	216	1863 and earlier.
March	45,800	745	6,930	113	19,365	315	1864 and earlier.
April	50,375	847	13,140	221	32,861	553	1873 and earlier.
May	109.150	1,775	33,460	544	68,954	1,121	1896 and earlier.
June	170,090	2,858	8,450	142	103,504	1,739	All.
July	219,630	3,572	2,900	47	71,763	1,167	1900 and earlier.
August	78,210	1,272	1,888	31	24,500	398	1869 and earlier.
September	31,870	536	2,065	35	13,250	222	1863 and earlier.
October	21,100	343	3,186	52	12,777	208	1863 and earlier.
November	17,670	297	4,390	74	10,990	185	1862 and earlier.
December	13,780	224	4,240	69	9,942	162	1862 and earlier.
Total	794,685	----------	95,149	----------	391,167	----------	

STATUS OF WATER RIGHTS

The rights and priorities of many water users within the Walker River Basin were established by a decree (No. 731) of the United States Court for the District of Nevada, dated March 22, 1919, in the suit entitled "Pacific Livestock Co. *v.* T. B. Rickey et al." The claims of the Indians, or of the United States for them as its wards, were not presented during the trial of this suit. In the decree, however, they are granted certain priorities, based apparently upon the findings and recommendations of the State engineer of Nevada. This decree determines the rights and dates of priorities for 83,613 acres of land requiring a flow of 1,162.6 second-feet; 57,784 acres are within the Walker River irrigation district in Nevada, and 25,829.35 acres in California. (See tabulation of decree No. 731 in appendix.)

The quantities of water granted in this decree, determined by Henry Thurtell, special master in chancery (then State engineer of Nevada), vary as follows:

	Second-foot per acre
For Antelope and Bridgeport Valleys	0.02
For Desert Creek and other tributaries	.016
For Smith Valley from West Walker	.0135
For Mason Valley, average	.0125
For Walker Lake Valley (reservation)	.012

The decree permits the diversion and use of water for irrigation, watering of stock, and domestic uses. The only qualifying statement as to these rights is that the parties have a right to the quantities granted as long as the river will supply that amount, and as long as the water is put to any of the beneficial uses mentioned above.

This decree and the impracticability of its enforcement has resulted in grave injustice to the Indians whose rights have constantly been infringed upon. The Antelope Valley Land & Cattle Co. can divert, under this decree, a total of approximately 168 second-feet, with a priority date of 1868 or earlier for the flooding of pasture and watering livestock. The earliest right recognized in the findings of

Special Master Thurtell, for the Indians, was 4.7 second-feet, with a priority date of 1868. The 23-year average of total Walker River run-off for the years 1903–1926, as shown in the foregoing tabulation (Table III), shows that the average normal flow of river can not supply any rights under decree No. 731 during the period of August to March, inclusive, with dates of priorities later than 1864. The total amount of appropriations with priorities of 1864, or earlier under this decree, is 300 second-feet.

There is no provision in the decree for river regulation or the appointment of a watermaster to equitably distribute waters among appropriators and regulate diversions. The decree provides for the appointment of the State engineer as commissioner only upon complaint and application.

During the past few years the river has been controlled entirely by the Walker River irrigation district. Three members of the board of directors of the district were appointed water commissioners, each having separate divisions of the river under his supervision with no one person in responsible control of the river. It is rather ridiculous to expect satisfactory river administration and distribution under the present system where river regulation is entirely under the divided authority of men who own or represent the largest land interests in the basin. It is stated that each ditch rider employed by the district is issued a commission by the governor of the State, giving him State authority in the handling of water.

It is now generally recognized in well-developed irrigated sections of the country where waters of streams are the most valuable public asset that river administration is one of the most important of public businesses, requiring trained men of the highest ability, qualified for the work by experience, knowledge of technical details, and with good judgment and diplomacy. The questions of river losses and return flows, now of the utmost importance in the economical use of water, require several years of systematic investigation work and close study.

It is interesting to record here that at the instance of Walker River landowners the United States Bureau of Reclamation investigated the Walker River Basin as a possibility for a Federal project, and the results of the investigation were reported in June, 1915, by Mr. J. C. Stevens, of Portland, Oreg. It is stated that they were unable to secure governmental aid because they could not agree upon a comprehensive plan of development, which would require the pooling of all water interests and the revoking of priorities of appropriation as set forth in decree No. 731 in favor of one common water interest. A former chief engineer of the Walker River irrigation district in his report recommending storage for the district stated: "The present methods and use of water are wasteful. The area under irrigation should be reduced, and waste lands now irrigated should be eliminated." He recommended the "pooling of water rights of district landowners and the construction of larger distribution canals to effect greater economy in the use of water and reduction of transmission losses"—now extravagant in the distribution of water by numerous small and individual ditches diverting from the river. Under the present scheme of operation individual rights and priorities are recognized, and numerous small diversion ditches are operated and maintained by the landowners, the district only supervising river diversions and the carriage of stored water from the Bridgeport and Topaz Reservoirs.

In his report of June, 1915, Mr. J. C. Stevens states:

Obviously the only logical plan of development for this basin is one that will put the entire available water supply to its utmost use, thereby bringing as large an area as possible under irrigation. Such a plan can not be consummated if water is used in accordance with present practices, and the present schedule of water rights and priorities adhered to. There is no logic in the present schedule. The decreed rights are almost meaningless and utterly impracticable of enforcement.

There is ample water for all lands now under ditches and a liberal surplus for additional reclamation if storage be provided. A condition far better than the present one would result if present rights were forgotten and a comprehensive plan of development executed.

* * * * * * *

Lands actually irrigated.—The lands irrigated are those determined from surveys made in 1905 by the United States Reclamation Service, and probably more nearly represent the actual irrigated areas than those shown in the tables. It is not likely that any considerable increase has been made in irrigated area since that date, on account of the limited water supply. Table IV gives a summary of the areas of land actually irrigated in the three lower valleys, as determined from these surveys.

TABLE 4.—*Areas actually irrigated in the three lower valleys of the Walker River Basin in 1905*

[Stevens's report, 1915]

	Acres
Smith Valley (from United States Reclamation Service surveys)	5, 680
Mason Valley (from United States Reclamation Service surveys)	23, 540
Walker Lake Valley (by F. Weber, 1915)	900
Antelope Valley (estimated)	5, 000
Bridgeport and other Valleys (estimated)	10, 000
Total	45, 120

Decree No. 731 allows 923.68 second-feet for approximately 66,500 acres as the area under irrigation in 1885 and earlier.

Mr. L. A. Palmer, inspector, Department of the Interior, in his report of December 28, 1922, to the Commissioner of the General Land Office, on the examination of lands and proofs for the Walker River irrigation district, also made a detailed investigation of the water rights of the district and district lands.

The status of district lands is shown as follows in the Palmer report:

Area of irrigable lands, Walker River irrigation district (Table 17, Palmer report)

Valley	Patented lands with decreed rights	Patented lands without decreed rights	Unpatented lands	Total
UNDER WEST WALKER RIVER	*Acres*	*Acres*	*Acres*	*Acres*
Antelope	1, 200	12, 425	375	14, 000
Smith	8, 600	17, 200	14, 200	40, 000
Mason	3, 100	5, 030	6, 870	15, 000
Total	12, 900	34, 655	21, 445	69, 000
UNDER EAST WALKER RIVER				
East Walker	4, 020	6, 830	3, 150	14, 000
Mason	9, 780	5, 900	8, 320	24, 000
Total	13, 800	12, 730	11, 470	38, 000
UNDER MAIN WALKER				
Mason	31, 110	22, 070	3, 820	57, 000
Total of all	57, 810	69, 455	36, 735	164, 000

WATER RIGHTS

The status of water rights as shown by the Palmer report is as follows:

The district is basing its water rights on 16 filings under the California water law, 1 old appropriation under the California law, and 2 filings under the Nevada water law.

CALIFORNIA FILINGS

No. 1097 filed September 27, 1918, by W. M. Kearney for 35,000 acre-feet per annum at the rate of 1,000 cubic feet per second. This covers the so-called Lake Leavitt storage in Tps. 5 and 6 N., R. 22 E., and will provide water for the irrigation of lands in Antelope Valley.

No. 1098 filed September 27, 1918, by W. M. Kearney for 115,000 acre-feet per annum at the rate of 1,000 cubic feet per second. This covers a possible (but not probable) construction of a reservoir in Pickle Meadows in T. 6 N., Rs. 22 and 23 E., which would supplement the other storage and be used principally in Antelope Valley.

These applications, Nos. 1097 and 1098, were transferred to the district June 22, 1922, and the transfer is recorded in book U, page 22, of the record of Mono County, Calif.

No. 1388 filed August 8, 1919, by the Walker River irrigation district for 100,000 acre-feet per annum from Murphy Creek, a tributary of East Walker, to be impounded by a dam in sec. 15, T. 6 N., R. 25 E. This filing has been made in a very indefinite manner, apparently for the purpose of starting a right which would be completed later.

No. 1389 filed August 8, 1919, by the Walker River irrigation district for 63,000 acre-feet per annum from the East Walker River. This is for storage in the proposed Bridgeport Meadows Reservoir, the principal feature of the project on the East Walker River.

The Bridgeport Reservoir was completed in April, 1925, and final proof on this permit granted by the State of California.

No. 2221 filed February 21, 1921, by the Walker River irrigation district for 85,000 acre-feet per annum to be diverted from the West Walker at the rate of 1,000 cubic feet per second. This filing is for diversion to Topaz Lake for use in Smith and Mason Valleys.

Final proof on this permit has been made in the construction of Topaz Reservoir.

No. 2615 filed October 28, 1921, by the Walker River irrigation district for the entire flow, up to 200 acre-feet per annum, of an unnamed stream tributary to Topaz Lake.

At the office of the State Water Commission of California I was advised that permits will be issued for Nos. 2221, 2222, 2223, and 2615.

The present status of these is shown by the following letter:

DEPARTMENT OF PUBLIC WORKS,
DIVISION OF WATER RIGHTS,
Sacramento, Calif., June 18, 1926.

Applications Nos. 1097, 1098, 1389, 2221, 2615. Permits Nos. 2534, 2535, 2536, 2537, 2538.

W. M. MAULE,
Supervisor, Mono National Forest, Minden, Nev.

DEAR SIR: You are advised that the State department of public works, division of water rights, has, under date of June 18, 1926, granted permits Nos. 2534, 2536, 2537, 2538 to Walker River irrigation district for the appropriation of water from East and West Walker Rivers and from an unnamed stream to Topaz Lake for irrigation, stock watering and domestic purposes. To be diverted within:

1097. SE. ¼ SW. ¼ sec. 27, T. 6 N., R. 22 E., Mount Diablo meridian. (Leavitt meadows.) 1098. NE. ¼ SE. ¼ sec. 17, T. 6 N., R. 23 E., Mount Diablo meridian. (Pickle meadows.) 1389. SE. ¼ NE. ¼ sec. 34, T. 6 N., R. 25 E., Mount Diablo meridian. (Bridgeport Reservoir.) 2221. SW. ¼ SW. ¼ sec. 24, T. 9 N., R. 22 E., Mount Diablo meridian. (Topaz Reservoir.) Temp. SE. ¼ SE. ¼ sec. 12, T. 9 N., R. 22 E., Mount Diablo meridian. 2615.

SW. ¼ SE. ¼ sec. 27, T. 10 N., R. 22 E., Mount Diablo meridian, and to be used within Walker River irrigation district on 160,000 acres. (Unnamed tributary of Topaz Reservoir.)

The terms of the permits are as follows:

	Acre-feet
1097	35, 000
1098	115, 000
1389	57, 000
2221	85, 000
2615	200

Seasons of diversion to storage:
1097, 1098, 2615. January 1 to December 31 of each season.
1389. September 1 to July 20 of each season.
2221. October 1 to July 15 of each season.

Construction work to begin on or before:
1097, 1098. August 1, 1927.
1389, 2221, 2615. October 1, 1926.

Construction to be completed on or before:
1097. December 1, 1928.
1098. December 1, 1929.
1389. July 1, 1927.
2221, 2615. June 1, 1930.

Water to be applied to use on or before:
1097. August 1, 1930.
1098. August 1, 1930.
1389. August 1, 1929.
2221, 2615. August 1, 1932.

Special term.—Permittee shall keep, and furnish to the division of water rights upon demand an accurate record of gauge heights in Topaz Reservoir.

Very truly yours,

EDWARD HYATT, JR.,
Chief of Division of Water Rights.

In answer to a recent inquiry relative to other California rights, the division of water rights, California, writes as follows under date of October 29, 1926:

There are no appropriations before this office on the East Walker River other than application No. 1389 of the Walker River irrigation district. This application was filed August 8, 1919, and its priority of right dates from then.

This application was approved and permit issued June 18, 1926, under the terms set forth in the inclosed copy of our letter of June 18, 1926. No rights to direct diversion at any time of the year were initiated before this office, but it is understood that certain of the lands comprising the district possess such rights by virtue of early appropriations and the exercise of their riparian rights.

The district formerly had filings on Upper and Lower Twin Lakes and on Sommers Creek. However, they withdrew these applications and at present there are no filings on the sites. Should permits be granted at some future time for storage in Twin Lakes, diversion thereunder would, of course, be subject to prior rights to the waters of the stream whether for direct use or storage.

EDWARD HYATT, JR.,
Chief of Division of Water Rights.

NEVADA FILINGS

[From Palmer report]

The following filings have been made in the State of Nevada:

"No. 5440, filed January 25, 1919, by C. C. Tidd, trustee for East and West Walker water users, for 3,000 second-feet from the East Walker River to be diverted practically at the State line and used in East Walker and Mason Valleys. This application was transferred to the district June 2, 1919, and filed with the State engineer July 9, 1919.

"No. 6853, filed October 28, 1921, by Walker River irrigation district for 2 second-feet from an unnamed stream, to be diverted in NE. ¼ NW. ¼ sec. 32, T. 10 N., R. 22 E., and stored in Topaz Lake."

PRESENT TITLE TO WATER

Of the above, California applications 1097 and 1098, the old Rickey appropriation, and Nevada application 5540 were initiated by others than the irrigation district. All of these have been transferred to the district, however, so that all evidence of title to the water rights on which it will be dependent is vested in it.

No permits have been granted under any of these applications. The State engineer of Nevada has deferred action pending the adjustment of some prior applications, and the State water commission of California has taken no action, as it was considered advisable to secure a settlement of all protests and other conflicts before issuing any permits. Meantime, extensions of time have been granted to keep the applications pending and valid.

ADVERSE RIGHTS

Decreed rights.—In 1902 Miller and Lux commenced suit against Thomas B. Rickey et al. for the purpose of adjudicating the flow of the East Walker, West Walker, and main Walker Rivers. There were a large number of other defendants besides Rickey, a number of intervening defendants, and a number of substituted defendants. During the course of the action both the Miller and Lux and the Rickey interests, were sold and when the case was finally decided on March 24, 1919, it was as Pacific Live Stock Co. *v.* Antelope Valley Land & Cattle Co. et al.

By agreement among the various parties to the action the court appointed Henry Thurtell, then State engineer of Nevada, special master for the purpose of ascertaining and fixing the rights of the several parties in interest. After thorough investigation and the taking of much testimony on the part of the master, an agreement was reached among all of the parties to the suit, and on the date above given the court entered decree No. 731 in the case. This decree fixed the amount of water to which each party was entitled, the source of the water, the area to which it was to be applied, and the priority of each use. These findings are set forth in Table I, appendix, which gives all of the information in concise form. The table as given is divided into different streams and each stream into divisions according to location of the gauging stations. The table is divided vertically to give the priorities according to years and horizontally to give the water users. It will be noticed that there are two figures wherever an entry is made. The upper of the two figures gives the right acquired in that particular year and the lower figure the total acquired at that date by that user. From this table it appears that the following rights have been decreed:

	Second-feet
Tributary creeks	77.60
East Walker	310.46
West Walker	399.71
Main Walker	396.32
Total	1,184.09

Four creeks tributary to the main streams are included in these findings, but these need not be considered as affecting adversely the water available for the district's use. These creeks are Bodie, which empties into the East Walker in sec. 30, T. 7 N., R. 27 E.; Rough, a tributary of Bodie; Sweetwater Creek, emptying into the East Walker in sec. 25, T. 7 N., R. 25 E.; and Desert Creek, emptying into the West Walker in sec. 24, T. 11 N., R. 23 E. It will be seen that all of the increment to the main streams from the creeks in question is below the storage sites of the district, and the only effect they would have on the water supply of the latter would be that in some years of large run-off they would add to the amount available by direct diversion. Deducting the 77.60 second-feet of the tributary creeks leaves 1,106.49 second-feet decreed rights which the district must take into consideration in any estimates of water supply.

Intervening applications.—Examination of the records of the State water commissioner of California shows practically no filings in that State adverse to the district aside from old adjudicated rights. The only permit issued is No. 125, filed May 15, 1916, by Andrew Smith for 60 miner's inches (1½ second-feet) to be diverted in the SE. ¼ NW. ¼ sec. 28, T. 4 N., R. 24 E., on the East Walker watershed.

Aside from this there are a few, not more than five all told, permits for stock or domestic use. None of these is in excess of one-half a second-foot and the total, including the Smith permit, does not equal 3 second-feet. Hence I have disregarded them in a consideration of available water.

Table 7 is a list of permits and filings on the East, West, and Main Walker Rivers in Nevada which have intervened between the last of the decreed rights and the applications filed by the district or in its behalf. From this it appears that permits have been granted for 441.01 second-feet to be applied to 44,294 acres, of which certificates have issued for 31.73 second-feet to be applied to 3,347 acres. In addition to the above, there are pending applications for 212.35 second-feet.

TABLE No. 7.—*Applications and permits for water on East, West, and main Walker Rivers between decreed rights and applications of Walker River irrigation district*

Name	Date	Number of filing	Acres under permit	Second-feet under permit	Water applied for
EAST WALKER					
J. D. Butter et al	May 8, 1911	2040	960	9.6	----------
Oliver A. Perry	Apr. 26, 1915	3369	240	2.4	----------
Chas. C. Perry	do	3370	200	2.0	----------
Stall Bros. for power only—equivalent	Mar. 25, 1916	3846	5,000	50.0	----------
John H. and Jas. H. Wickman	Dec. 12, 1916	4246	100	1.0	----------
Annetta D. Lewis	Apr. 2, 1917	4381	----------	----------	1.0
R. W. and W. C. Allum	Jan. 22, 1918	4856	----------	----------	2.8
Geo. N. Fish	Mar. 12, 1918	4957	----------	----------	2.0
Total	----------	----------	6,500	65.0	5.8
WEST WALKER					
Walker River Indian Reservation	Aug. 12, 1906	182	32	[1] .32	----------
Frank A. Arentz	Jan. 20, 1909	1258	80	[1] .80	----------
Paul Regli	Oct. 25, 1909	1476	308	3.08	----------
J. D. Yeager et al	Feb. 23, 1910	1619	320	2.66	----------
Henry Carney	Mar. 21, 1910	1630	160	[1] 1.33	----------
I. Cohn	Apr. 18, 1910	1663	9,600	[2] 96.00	----------
Samuel Arentz	Aug. 4, 1910	1776	320	3.2	----------
C. C. Turner	Feb. 5, 1912	2331	35	[1] 3.5	----------
Franklin A. Arentz	Oct. 9, 1912	2523	220	2.2	----------
Frank W. Simpson	Jan. 27, 1913	2620	11,940	119.4	----------
George E. Wilson	Nov. 6, 1916	4209	240	2.4	----------
Plymouth Land & Stock Co	Nov. 22, 1916	4228	----------	----------	20.00
Paul Regli	Apr. 10, 1917	4391	----------	----------	1.63
Frank W. Simpson	May 2, 1917	4422	----------	----------	211.00
Louis Saroni for power	Aug. 14, 1917	4539	----------	----------	150.00
Union Land & Cattle Co	Sept. 8, 1918	4570	----------	----------	200.00
J. J. Martin	Sept. 21, 1918	5254	----------	----------	.40
Chas. A. Hendel	Jan. 20, 1919	5363	----------	----------	195.60
Total	----------	----------	23,255	231.74	778.63
MAIN WALKER					
Antelope Valley Land & Cattle Co	Jan. 12, 1912	2308	3,675	36.75	----------
Do	do	2309	850	8.5	----------
J. B. Gallagher	Apr. 12, 1912	2406	1,389	13.89	----------
H. J. Humphreys	Oct. 18, 1912	2533	320	3.2	----------
F. J. Conway	May 8, 1918	5120	----------	----------	2.45
John D. Kemp	Aug. 2, 1918	5188	----------	----------	1.00
Ottmer Sauter	do	5189	----------	----------	1.00
Jeff D. Luvin	Aug. 8, 1918	5198	----------	----------	1.50
Arnold Sciarani	Aug. 12, 1918	5202	----------	----------	1.50
Patrick Donovan	Aug. 26, 1918	5233	----------	----------	1.50
Joe Ponto	Sept. 24, 1918	5258	----------	----------	2.00
Total	----------	----------	6,234	62.34	10.95
EAST AND WEST WALKER					
W. M. Rollin et al	Oct. 7, 1909	1449	465	5.0	----------
Perazzo Bros	Apr. 14, 1910	1658	3,040	[1] 28.93	----------
Walker River Indian Reservation	Dec. 24, 1910	1914	4,800	48	----------
Total	----------	----------	8,305	81.93	----------
Grand total	----------	----------	44,294	441.01	795.38

[1] Certificate issued.

[2] Filing made for 28,800 acre-feet.

There is no way of estimating accurately the amount of water for which certificates, based on these applications, will finally issue. It is probable that none of the larger applications on the West Walker will ever materialize as a definite right. No work has been done on any of these, namely, 4422, 4539, 4570, and 5363. No. 4422 was made by Frank W. Simpson for Louis Saroni, applicant for No. 4539 for power purposes.

Application No. 4570 by the Union Land & Cattle Co. was filed in 1918 for the purpose of irrigating a tract at the north end of Antelope Valley. No development has been performed on this application and it is doubtful if there ever will be.

Application No. 5363, by Charles A. Hendel, was filed for the purpose of bringing water to a tract of high land in the northeast part of T. 11 N., R. 23 E., and the northwest part of T. 11 N., R. 24 E. In order to bring water to this land a siphon about 2 miles long from the Simpson ditch would be required and it would be necessary to enlarge that ditch. This project was conceived by several people in that locality but practically all of those interested, including Hendel, have moved away.

Taking these conditions into consideration, the applications filed between the decree and the organization, which may eventually ripen into adverse rights, may be summed up as follows in Table 8:

TABLE 8.—*Probable net adverse rights from applications made between the court decree and organization of the district*

Stream	Permits	Applications
	Second-feet	*Second-feet*
East Walker	15.0	5.8
West Walker	231.74	22.03
Main Walker (including East and West)	144.27	10.95
Total	391.01	38.78

Combining these figures with the decreed rights as given in table in appendix, we have total adverse rights as given in Table 9.

TABLE 9.—*Total rights adverse to district*

	East	West	Main	Total
Decreed	310.46	399.71	396.32	1,106.49
Filed	20.80	253.77	145.22	419.79
Total	331.26	653.48	541.54	1,526.28

EFFECT OF ADVERSE RIGHTS

It must be understood that this only conveys rights to the flow of these streams in the above amount when available from the natural flow and gives no storage rights. In the course of an ordinary season the latest of the decreed rights are out of water by about July 10, and from then on they run short in the inverse order of their priority.

It can not be gainsaid, and there is no "side stepping" the fact, that if all of the owners of decreed rights were to insist on the full amount of the decree for all of the land involved, the supply would be so depleted as to raise a serious question as to the feasibility of any considerable expenditure for the purpose of developing the remainder. The court assumed a 150-day season and granted some rights as much as 1.6 second-feet per hundred acres, equal to a seasonal depth of 4.8 feet. Such a use is entirely unnecessary and, in fact, would be injurious. (From report of L. A. Palmer, inspector, U. S. Land Office.)

NECESSITY FOR STORAGE

The subject of storage or a more dependable irrigation water supply for the Walker River Reservation has been a serious consideration since the inception of the irrigation system, and every superintendent in charge of the reservation has strongly recommended the construction of a storage reservoir.

The office is no doubt familiar with the past water supply difficulties, as correspondence on the subject in the local files is very voluminous and the inclusion of all tbis in the report would require considerable space. The following brief extracts and excerpts copied from letters and reports summarize early opinion on the subject.

Report of Walker River Agency Pah-Ute Indians

Walker River Reservation,
July 22, 1899.

The Commissioner of Indian Affairs
(Through Superintendent James K. Allen).

Sir: I have the honor to submit herewith this my first annual report of the Walker River Reservation for the fiscal year ending June 30, 1899. Although this is my sixth year at this place, it is the first time I have been accorded the privilege of making a written report to your office.

RESERVATION

This reservation contains nearly 320,000 acres, only about 20,000 of which is arable. The remainder, with the exception of a lake about 18 by 28 miles in extent, is mountainous and barren, except a small portion well up in the mountains which is covered with mountain pine. There is now under cultivation about 1,300 acres, which is nearly all that can be covered by our present ditches.

Owing to the light precipitation in the mountains during last winter and the winter before, we have been short of water for irrigating purposes two years in succession—this year, however, not quite as short as last.

There is always plenty of water, and to spare, in Walker River, from whence we get our supply during most of the year; but our trouble in this respect lies in the fact that it does not always hold out during the entire summer. Last year we had no water for irrigation purposes after about the 10th of July, and an insufficient quantity for at least two weeks preceding that date. This year the supply has lasted longer. While there is at present an insufficient quantity for our needs, I think we will not be entirely without until about August 1. From the foregoing facts, it is obvious to anyone familiar with the short summers of this locality that this shortage of water during the last half of the growing season is a serious hindrance to our farming industry. Especially is this the case to nearly all vegetables growing. During the first four summers of my stay here the cultivated area was increased more than 50 per cent. The increases in grain (wheat and barley) yield was more than 300 per cent, while the vegetable crop had grown from nothing to quite a respectable showing. In addition to a large quantity being consumed by the Indians themselves, several tons were shipped out.

Last year, on account of the failure of water, as above stated, our grain crops were cut short about 40 per cent of what they were the preceding year, while our vegetable crop was an entire failure.

This year the water lasted a little longer and insures us that the grain and hay crops will mature. I estimate that each of these crops will be about the same as two years ago.

Owing to the evidences of a shortage of water late in the summer, but few vegetables were planted this year, and it is well so, for only a few of those planted can mature.

It is our aim to be able to report a steady increase in farm products each year, but when these dry years come a setback is inevitable, as things now are, but they can be remedied.

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By the construction of a dam across a canyon, through which Walker River runs, about one-half mile above our present dam, of sufficient height, a large reservoir several miles in extent can be made; thus not only insuring us against a possible drouth in the driest years, for what land we now have under cultivation, but with this done, and the construction of about 10 miles of ditch, about 10,000 acres additional can be brought under cultivation, and all insured against a possible drouth. This, in my opinion, is not only feasible but can be done at a total cost of less than $3 per acre for the land covered.

If the Pah-ute Indians contiguous to this reservation (of which I estimate there are from 1,000 to 1,200) are to be induced to come out of the opium and whisky dens in the surrounding country, and come onto the reservation, make their homes here, and, together with those already here, make themselves self-supporting, I would most respectfully recommend that the above-described reservoir be looked into, by one fully competent to determine its feasibility and the benefits resulting therefrom.

These Indians are easily induced to farm if land, with an assurance of water therefor, and agricultural implements are furnished them. The latter we constantly need more of in order to properly do what we are now attempting.

Five years ago the Indians here had not attempted the raising of domestic fowls. Since that time they have been induced to take up this industry and now quite a number of families are raising chickens. Collectively, they now have several hundred.

I have not encouraged them to increase their acreage in hay, for the reason that they were, and are, raising more than they need for home consumption and grain and vegetables pay them much better."

* * * * * * *

Very respectfully,

L. A. Ellis, *Farmer in Charge.*

Department of the Interior,
United States Indian Service,
Schurz, Nev., July 23, 1905.

Mr. C. H. Asbury, *Superintendent Carson Indian School,*
Carson City, Nev.

Dear Sir: Will go to Mason Valley to-morrow (Monday) going up the river to Millers Dam.

Understand they closed their gates several days ago, and Indians tell me all the water we are getting is their waste that comes back into the river channel from their brush land.

Going to investigate, and if find as stated, will go and see Gifford, as representing Lux & Miller, and notify him to turn down some of the water. Of course they won't do it, but you will have to get Summerfield to start an immediate injunction against Miller, and probably the whole valley as a whole. If necessary, Hulbert as Government engineer might be utilized for measuring.

We have got to scrap for the water this year if we have to take it. The Indians' rights are involved and ought to be fought for against the grabbers and thieves of Mason Valley.

If the Government don't settle the water question for the Indians, I can assure you the allotment question will not sail along very amicably.

Will try and be back Tuesday.

Very respectfully,

R. A. Lovegrove, *Agent.*

Chief Engineer Code, in his report dated July 7, 1906, to the Secretary of the Interior, states:

It is an unfortunate fact that the Indians of the Walker River Reservation will not be able to obtain any considerable amount of water during seasons of scant supply after July 1.

The white settlers above them have been occupying and farming lands in Smith and Mason Valleys for over 40 years, taking out ditches in the early sixties and having earlier priorities of appropriation than the Indians, whose first attempt at ditch construction was begun in about 1868 by the building of a small ditch and irrigating only a few acres of land. While they enjoy an early priority of diversion the area of land irrigated was small.

If they can establish title to sufficient water during such periods to irrigate one-third of their present farmed areas of some 1,400 acres, it will be as much as we can reasonably count upon. United States attorney, with the data that has been furnished him by Special Agent Conser and Superintendent Meskimmons, will undoubtedly secure their rights in the premises; but as matters stand it is altogether probable that the larger portion of Indian holdings now in cultivation will be forced to depend chiefly on surplus spring and early summer's water for an irrigation supply.

Considerable correspondence of the same tenor indicate that the Indians have always been handicapped by lack of a late season water supply.

The following petition was submitted by the Indians in 1919, requesting governmental aid in securing an adequate and dependable water supply:

A petition to Congress of the United States (through the honorable Secretary of the Interior and the honorable Commissioner of Indian Affairs) by the Indians of the Walker River Reservation, presented by their delegation to Washington, viz, Dick Sides, George Knerim, and James X. Willie

Whereas your petitioners respectfully offer the following:

As we look back to the year 1860, as remembered by John Dave, then our reservation was established. There has been a little change as it stands to-day.

Superintendent Dodge was our first superintendent, and he was a good man. Under all of his orders we advanced; his aim was to lift us up as a tribe so that we might be of value in the world. He did all in his power in instructing the Indian to produce their wants. He also told us in the near future the Government would build a home or house on every allotment, so that we might be well and contented; also telling us to do what is right which would make us the best people.

Superintendent Jim was our next superintendent. He was also a good, kind man. He told us to stick to the task of farming, never to give up, and in the future we would be glad; telling us that every inch of land on the reservation is ours, and that no white man can come in without a permit; that if they should camp on the reserve they should pay a little fee; that if all are honest and do the best way there would never be any dispute among the whites and the Indians. That if we stick by one another and keep on the right side we will make the best reservation on earth. Superintendent Jim promised to help us, as he did; no other man could have done better.

Superintendent John Clark was the next superintendent. He was also a good, kind-hearted man, same as the rest; his whole idea was like the rest; to uplift us Indians. He told us to stay on the reservation and improve it and ourselves and to raise what would be of most value; telling us that the old ones would surely die but that the young people would come on to carry along the work and give the good advice given them. He said we were all little men and that we must take our orders from Washington, telling us that the time will come when bad men will try to beat the Indians in every way but that we must remember all that has been taught us.

Superintendent Frank Campbell was the superintendent who stayed the longest. He stayed with us a long time, so long that he could speak our language. He stayed so long that he seemed to be part of us. He said we could be the best Indians in the whole United States. He said a school would soon be opened up on the reservation and that he knew we would send our children, because we were doing as he wanted; that in years to come there would be superintendents who would surely beat us in all our dealings, and for us to look out, but that he has been helping us in every way and standing by us, and for that he was sent here.

OUR IRRIGATION PROJECT—WE NEED MOST A STORAGE DAM

We now beg of you, Mr. Secretary and Mr. Commissioner and Members of Congress, to listen to our present needs and to take an interest in us. This is most important, that we must have a storage dam. It is the cry of all these Indians and it is needed to save us. Our superintendent and the supervisors of irrigation have written you of the cost and of the great benefit to us and the Government. Now we have about 1,300 acres that has cost $100 an acre, and water fails us in the early part of July, causing much loss. With the storage dam we have nearly 7,000 acres that could be irrigated and the total cost of all would be less than $50 an acre, and water would be supplied through July, August, and September, saving one or two hay crops and our gardens and pastures.

Every superintendent who has been with us has urged the building of the storage dam—all say it is our salvation. We Indians have waited, but without success; our crops dry up early in summer and our stock suffers. Our Indians are afraid and discouraged, but with the dam and water sure we would take heart, and our reservation and the whole valley would prosper. Most of our Indians now have to go away to work to make the money to live, which is bad for them and their children.

If you could carry this through, Mr. Secretary and Mr. Commissioner, it would gladden our hearts and we Indians of the Walker River Reservation would be very thankful.

There are new irrigation projects above us that we fear will take our water if this dam is not built to hold our rights; we are afraid that each season will see less and less water for us, until we may have to all go away to work in order to support our families. And if we go away our stock suffers and is strayed away, lost or stolen; so we must have this dam.

We, the adult Indians of the Walker River Reservation, earnestly pray that this petition may find favor in your eyes, and that Congress may act promptly, for we are in need.

Signed, at Schurz, Nev., this 3d day of November, 1919:

CAPT. ABE MCCLOUD.
GEO. ABE.
HARRY JOHNSON.
JOHN H. MILLER.
BILLY MILLER.
WILD BILL LOWE.

(Signed by all present, about 150.)

WALKER RIVER SCHOOL AND AGENCY,
Schurz, Nev., August 4, 1919.

COMMISSIONER OF INDIAN AFFAIRS,
Washington, D. C.

SIR: The irrigation situation on this reservation at the present time is as follows:

About 1,350 acres are under ditches, all of which are of the most temporary character and subject to wash. They require constant "riding" and repair. The cost to date has been something over $100 per acre. There is no water at this writing and the Indians' crops are suffering.

These Indians have about 6,000 acres of fertile irrigable land in this valley, all very productive. To properly irrigate this land would require a storage dam costing approximately $100,000 and an additional outlay of $25,000 to $50,000 for necessary ditches, laterals, etc.

The system complete would total less than $50 per acre including all past expenditures and require no more for supervision than the present incomplete system which has cost over $100 per acre, and with a water shortage confronting us that must be overcome at once or the Indians will suffer further losses, to say nothing of the discouragement to them, retarding their progress, etc.

As the matter stands now it will be necessary to add approximately $150,000 to the $150,000 already expended or the entire investment will be a loss.

Your immediate consideration of the situation is urged.

Very respectfully,

JAMES E. JENKINS, *Superintendent.*

WALKER RIVER INDIAN AGENCY,
Schurz, Nev., August 8, 1924.

COMMISSIONER OF INDIAN AFFAIRS,
Washington, D. C.

DEAR SIR: In reply to office letter of July 23, 1924, calling attention to report of Henry W. Phillipson, farmer, in which statement is made that the water supply will not be sufficient to mature the crops and which a report on the water situation is requested, you are informed as follows:

I would first call attention to letters from this office dated April 25, May 31, July 16, and July 30, 1924, and to the letter from Superintendent Darrington, of the Sacramento Agency, dated April 30, 1924, relative to the situation here and the efforts that were made to secure water for the Indians.

On June 6, 1924, I wired the office that the water commissioner at Yerrington would send us no more water and the water sent by him was exhausted on June 15, 1924, since which time we have had no water, and all crops except the first cutting of alfalfa and in a few cases, a short second crop, have burned up.

To say that the water situation is serious is putting it mildly. Wells have been put in by the Indians, and as the water from the sands was lowered they have gone dry. The cattle have been brought to the lake and many of the Indians have been feeding, but as the water would give out they would have to turn out their cattle for water. Several cattle which strayed, have perished from famine, and all of the cattle, because of the scarcity of feed, are in poor condition.

The Indians are discouraged, and, while they seem to be making the best of a serious situation, it will put them back for a year, and, if there is a great loss of cattle, for several years. We are endeavoring to secure water out in the Rawhide district so the cattle can be placed there and the general mechanic and myself are going out to-morrow to see what can be done along the line of securing watering places in that section.

A great many of the Indians have depended upon the water from the agency pumping plant for all of their needs. Lately the agency well has shown signs of failing as we can only pump 2 feet at one time and then it is dry. This is repeated in order to hold sufficient water in the tank for fire protection. We have been watering the lawns and small gardens at the agency from the tank, but I have been compelled to ask everyone to let their lawns and gardens go and shall supply the Indians and the agency force from the well only for drinking purposes.

The cattle situation is the most serious, and it may be necessary, should we fail to get water in the Rawhide country to ship them out and sell them as stockers. It is to be hoped that this will not be necessary as there would be a great loss from such a course. The feed along the lake will be sufficient for a time, and we shall try and work out some solution for the future care of the cattle before that supply is gone.

The Indians have the first cutting of alfalfa, but, as explanation has been made in previous correspondence, the first cutting of alfalfa is used by these Indians for their living expenses and nearly all of them have traded at the store and wish to use this hay to settle their indebtedness. If they could feed this, they could make corrals at the lake and get the cattle through the winter in good shape. There is feed in the hills and on the flats but too far for the cattle to use because of the distance to water.

The office will be kept informed as to the situation and the outcome as to our efforts made to secure water for the cattle.

Very truly yours,

G. A. Trotter, *Superintendent.*

Walker River Indian Agency,
Schurz, Nev., January 2, 1926.

Commissioner of Indian Affairs,
Washington, D. C.

Dear Sir: In letter of January 1, 1926, a request was made that the order of December 21, 1925, asking for my attendance at the water conference in Washington, now given as January 20, 1926, be recalled as it would be difficult for me to leave here at that time because of the pending transfer of the chief clerk, L. W. Shotwell. If my presence there is not required, I am taking up certain phases of the water situation which I would want to be brought to the attention of the one who represents the Indians at this conference or meeting.

While a decision of the Supreme Court of the United States, No. 158, October term, 1907, affirms that the setting aside of irrigable lands as and for a permanent abiding place for Indians, carried with it a water right for said lands, this right has not been recognized by the water users on the upper Walker River. On November 29, 1859, in a letter to the Commissioner of the General Land Office, A. B. Greenwood, commissioner, from the Office of Indian Affairs, directed the setting aside of certain lands on Walker River, now comprising what is now known as the Pyramid Lake Reservation, for use and occupancy of the Indians residing thereon.

In the findings in the action brought in the Federal court by which the waters of the Walker River were adjudicated, No. 731, Pacific Live Stock Co. *v.* T. B. Rickey et al., while the preliminary granted 22.93 second-feet to the Walker River Indian lands, as the United States was not a party to the suit, the final decree gave no rights to the Government in the waters.

Attention is called to the fact that the special master in chancery, Judge Talbert, appointed in the Truckee River suit, in his preliminary findings gives the Pyramid Lake Indians an 1859 right to the Truckee River waters. As the Walker River Reservation was set aside under the same order or letter of November 29, 1859, referred to in the second paragraph of this letter, there is no doubt but that a like decision would be handed down in the suit now in the Federal court should the action continue.

Recent surveys of the lands which could be placed under ditch and which could be classed as irrigable show that there are approximately 10,000 on the reservation. It has therefore been requested by the irrigation officials in charge of this district that 100 second-feet should be apportioned for use on the reservation.

I would call attention to the attitude of the drainage board for the upper river when an attempt was made during the season 1924, which was exceptionally dry, to secure a partial irrigation for the saving of some of the Indians' crops. The irrigation foreman for this place and myself appeared before this board and asked for one irrigation for our second crop of alfalfa. Under a previous agreement we had been assured of this one irrigation by Mr. Beemer, the water commissioner at Yerington, and some of the representatives of the drainage district. The drainage board refused to allow more water to be sent down and the president of the board, Mr. Wilson, who is to meet with the Washington body, stated to us that the Indians had no rights, never had and never would get any, and there was no occasion for granting any further concessions. As no other course was open, request was made of your office for court action in the case.

No water was received at the reservation after the 10th day of June, 1924. In the court action taken at that time it was agreed to turn loose an amount of water equalling five days' flow of the river at that time and allow this to flow to the reservation in one body to afford such relief as this would accomplish. This water, 120 second-feet on East Walker and 125 from West Walker River, was turned loose on July 23, 1924, after the river bed had been dry since June 10. The irrigation foreman, the farmer, and myself rode the upper ditches while the water was flowing but found so many head gates open and so much of the water escaping before it reached the reservation line that we knew the effort was futile, and only about 40 second-feet reached the weir at Yerington and a very small amount the reservation line, which is 30 miles from the land requiring irrigation.

The above experience is noted in the time of a water shortage to show the attitude of the upper water users toward allowing the Indians water. This attitude has changed to a considerable extent since the matter of securing the Indians' rights has been placed in the Federal court, but without some binding agreement it would be needless to expect relief at such a time from the upper water users or from anyone in charge of the water distribution.

There is no doubt but one solution of the problem of furnishing water for the lower river users without damage to the upper would be the construction of a reservoir on the upper reservation. This would gather the winter flow and would conserve the water now going to waste as well as allowing a proper handling of same during the irrigation season. With our small diversion dam it is not possible to handle a large head, and with the holding back of the waters when it would otherwise flow over the diversion dam a saving of a large amount of water would be effected.

Above the diversion dam there is more than 2,000 acres of land which could be made productive with the construction of this reservoir on the upper river. This land is already allotted, most of it is what is known as bottom land, and would, when compared with other projects in this State, make the building of the reservoir worth while if the entire cost was assessed against this land alone.

I have talked with some of the landowners on the upper river who realize that the rights of the Indians must be conceded in time, who would favor a joining in with the Government in the construction of this reservoir. While I think this is unnecessary, as the Indians can pay this under a reimbursable plan, there is no doubt but that such an arrangement would result in a great saving for these upper landowners if they would agree to such an arrangement.

It is to be hoped that some plan may be made in this meeting or conference to be held whereby the settlement of this matter may be had in a manner satisfactory to all parties. The vital thing is to have an early settlement, as under our present plan of handling the situation no assurance can be given the Indians that they will have water should they plant their crops, and consequently too large an amount of leveled, irrigable land lies idle.

Very truly yours,

———— ————.

EFFORTS TO SECURE WATER FOR SAVING INDIAN CROPS IN AUGUST, 1926

[From report of I. T. Whistler]

Despite the assurance given Superintendent Trotter and Foreman I. T. Whistler by the board of directors of the Walker River irrigation district at their April board meeting that they were prepared to and would allow us enough water to take care of all our crops this season, the entire flow of the Walker River was diverted by them so that this project was entirely without water by July 25, 1926. Our complaint to the United States district attorney was met by the counterclaim that the natural flow of the river was insufficient to reach the reservation if it were turned down in entirety. Engineer King and Mr. Whistler were designated to make a careful survey of both branches of the upper river, and on July 29 and 30 such survey was made. It was found that 16 second-feet of visible flow was going into the Bridgeport Reservoir, which is located on the East Fork of Walker River, and 40 second-feet was passing the United States Geological Survey gauge on the West Fork, making a total flow of 56 second-feet.

On Friday, August 6, after a series of conferences between users and attorneys representing the district and those representing the nonadjudicated users in California, who are also parties to our suit, it was mutually agreed that all the water consisting of natural flow entering the district, and also that being used by others, should be turned loose for a period of five days for use upon this project. This was done by Engineer King and Foreman I. T. Whistler on August 9, their efforts yielding 70 second-feet from the East Fork, exclusive of the back flow, which would be considerable for a part of the five-day period, and from the West Fork 31 second-feet additional was secured, which would make an aggregate of 101 second-feet, which, according to the verbal agreement, was to be passed through the district by the regularly appointed water commissioners. At 11 a. m. on August 12 they turned through the Antelope Valley Land & Cattle Co. dam past their last diversion, 20 second-feet; on August 13, 20 second-feet; on August 14, 22 second-feet; on August 15, 28 second-feet; on August 16, 28 second-feet; on August 17, 31 second-feet; on August 18, 16 second-feet; and on August 19, 5 second-feet, delivering us approximately 320 acre-feet of the 1,010 acre-feet turned down. It is noticeable that they were, at the same time, running in excess of 100 second-feet from each of their two reservoirs, on which it is believed the transportation losses are a trifle under 17 per cent, while the transportation loss on the water turned down for the Indians figures around 68 per cent while passing through the district lands and under the supervision of regularly appointed water commissioners.

The river channel below the Antelope Valley Land & Cattle Co. dam, and thence on down to our diversion, is very flat, sandy, and torturous, the distance being at least 35 miles, and, as the river had been dry for several days, loss before reaching our diversion was another 75 per cent of what was allowed to pass the district. The receipts into our canals were as follows: August 16, 6 second-feet; August 17, 8 second-feet; August 18, 8 second-feet; August 19, 9 second-feet; August 20, 5 second-feet; August 22, 2 second-feet; or a total of 80 acre-feet all told, at our diversion.

Owing to the delay mostly in conferences, our potato crop was beyond saving, and the crop losses sustained by the Indian farmers of this project will aggregate several thousands of dollars.

Respectfully submitted.

I. T. WHISTLER, *Watermaster.*

EXCERPTS FROM WALKER RIVER PROJECT IRRIGATION REPORTS

[From July, 1918, report, Walker River project]

The weather has been extremely warm nearly all the month and the shortage of water is causing much dissatisfaction among the Indian farmers. The small supply remaining is being used on gardens and potato patches only. Prospects were excellent before the water shortage but the outlook is now far from encouraging. It is impossible to prevent serious damage to most of the crops.

[From August, 1918, report]

Water distribution.—Up to the 20th of August the small stream of water available for irrigation was much in demand and it was used by rotation night and day in the effort to make the most of it. After the 20th it became too small to reach

any cultivated land. The weather has been warm and the lack of water has caused much loss in grain and hay. No water has been available for anything except gardens and potato patches since July 22.

[From September, 1918, report]

Water and crops.—No water has been available for irrigation since August 20 and a sufficient supply for all crops could not be delivered after July 22. The second cutting of hay was short and a third crop was not cut. Some of the wheat is fairly good but most of it lacked sufficient water for the last irrigation. Potatoes and gardens are fair.

[From June, 1919, report]

The water shortage here has become alarming. On June 23 and 24 we built a tight dike across the dam and turned all the available water into the canals. Five days later it became necessary to begin rotating, using only one canal at a time. At present we have only about one-half supply for one canal.

The ditch rider stays with the water and turns it from one field to another as fast as possible, and the stream is being used day and night.

This shortage is about a month earlier than last year. Unless the river rises again the crops will not amount to much, after the first cutting of hay.

All crops except first cutting of hay will be badly injured by water shortage, and this fact is taken into account in estimating the crop yields.

The shortage came 25 days earlier this year than last. On July 18, 1918, a dirt dike was placed across the crest of the rock dam diverting all water into the canals. The supply gradually diminished until on July 22 only about 5 second-feet was available and during most of August there was none.

On June 23, 1919, the dirt dike was made. On July 7, we had about 8 second-feet and the stream was rapidly diminishing. Indian farmers are much discouraged and some are talking of leaving the project.

[From July, 1919, report]

On the 1st of the month the scarcity of water began to be felt, only one canal being used at a time. On the 10th there was only enough for one irrigating stream. This rapidly dwindled till there was none at all on the 20th. The matter was taken up with the water master for the State, but the shortage for the whole system seemed to be so bad and the methods of water distribution so poor that little or nothing could be done for the reservation..

The reservation must have storage. It seems now that the quickest way to get it is for the Government to make arrangements with the Walker River irrigation district for temporary rights in one of the storage reservoirs to be built, pending construction of the storage works on the reservation, drainage works in Mason Valley, or some other permanent storage provision.

[From April, 1920, report]

Weather has been mainly cool and windy with a few warm days in the latter part of the month. Maximum temperature, 78; minimum, 15; mean, 47.5; precipitation, 0.02 inch.

Water distribution has been looked after rather closely in order to make a small stream go as far as possible. A small amount of maintenance work has been done.

The river has been very low, due to the late dry season last year and to the continued cool weather this spring. On the 8th of the month we requested the State engineer to put a water commissioner on the river, which was done. He states that since the 12th only 1870 priorities have been served. We are now receiving only about 6 second-feet at our diversion, which is the lowest on the river, but as this amount is a little more than our adjudicated rights of 1870 priority, it appears that nothing more is to be done but to wait for the spring run-off. It will not be possible to get enough water to all the small grain patches and gardens scattered over the project even by denying the hayfields, which are better able to wait.

[From 1920 annual report]

Water supply.—The principal disadvantage here is the uncertainty of the water supply. The project has adjudicated rights amounting to 22.93 second-feet with priorities dating from 1868 to 1886. Many of the older ranches in the valley

above the reservation have rights older than those of the Indians, so that this supply is usually partly or wholly cut off early in July. The rest of the reservation supply is flood water run-off in May and June.

Last season it was necessary to divert all available water in the river on June 24. On July 1 there was only about 10 second-feet available; on July 10, 5 second-feet; and on July 20 the supply was entirely exhausted. This season, on account of cool weather which has held back the run-off, there has been sufficient water to date, with exception of a shortage in the latter part of April and the first part of May.

These conditions discourage the Indian farmers as well as curtailing production of lands farmed. Cultivation of new lands is not advised, as this would only add to present difficulties in water service.

In a number of instances during water shortage the superintendent of construction has examined into the State water master's methods of distribution and has found that in each case the Indians were receiving as much or more than their decreed proportion. This, however, has been largely due to the fact that the return flow from the irrigation above usually amounts to as much or more than the share allotted to the reservation.

Storage studies.—A report summarizing storage studies that have been made was submitted in March. It is hoped that action can soon be taken in the matter of providing funds for obtaining the necessary late season supply.

The Indians seem very much interested in the matter of storage. In November they made up a contribution and sent three of their number to Washington to make an appeal for storage construction.

[From August, 1920, report]

On Walker River project no water for irrigation has been available during the month. Very warm weather continued up to the 24th. From the 24th to the 27th, 1.06 inches of rain fell, after which the weather has been cooler.

During the month the Indian farmers have harvested about 250 acres of wheat and barley and have finished the second cutting of about 1,200 acres of alfalfa. On account of the sudden failure of the water supply the second cutting of hay is not as good as was expected and no third cutting will be had.

[From 1921 annual report]

The water shortage during the late irrigation season is our greatest disadvantage. Until the present season we have been operating on the assumption that this project had adjudicated rights of about 23 second-feet, dating back to 1868, but the State engineer, under whose control the waters of Walker River have been placed by the United States district court, has taken the stand that we have no such rights and has been using every means possible to prevent us from getting any water. It probably will be necessary to substantiate the Indians' rights by legal action.

Last year the water was exhausted entirely by July 30, which was slightly later than the two previous years. This year the indications are that we will have a later supply than last year. The only shortage we have had this year has been in April, when the supply became as low as 3 second-feet.

These conditions discourage the Indian farmers as well as curtail production in general, but more especially their garden products. Could they have a late supply of water assured their garden products would be of considerable value, both for market and home consumption. The soil and climate are favorable for such farming.

A good many studies have been made with a view to developing a late water supply in some form, but so far no economical scheme has been found. It has been suggested that we make arrangements to buy an interest from the Walker River irrigation district in their Topaz Lake Reservoir. This plan seems to have more merit than any suggested so far, both as to practicability and economy. Present plans for Topaz Lake call for a storage capacity of 100,000 acre-feet at a cost of approximately $7 per acre-foot, while the cost of the reservoir on the reservation would be $130,000 for less than 10,000 acre-feet of storage.

Under the circumstances we have discouraged the Indians from cultivating any more new land, although many have expressed a desire to do so.

A casual investigation will disclose the fact that the Walker River Indians are honestly endeavoring to make the most of their opportunities. They have proven themselves to be very good farmers and are steadily improving their methods. They have for years raised good crops in the face of obstacles that

would discourage the best of white farmers. Chief among these difficulties, of course, is our lack of late water supply, which is getting more acute each year.

With the Walker River irrigation district's program of large storage reservoirs on both rivers we are confronted with more problems, and has opened the discussion whether it will be of benefit to us or vice versa. Those who are in a position to know say we will receive enough water from the return flow from Mason Valley to supply our needs, but it is debatable whether such will be the case.

It is recommended that we buy storage to the extent of 10,000 acre-feet and then make conclusions regarding the drainage situation. If it is proven that drainage will supply our needs, we can then easily sell our storage, as there is more land than apparent water supply in the Walker River Basin.

[From 1922 annual report]

The water supply on Walker River for the four years previous to this year has been very disappointing. We usually had no water at all after the 1st of August and some years we were without water on the 10th of July, just when it is needed the greatest. From all appearances we will have a good supply this year, probably running throughout the year. The Walker River irrigation district has completed the construction of the first unit of storage at Topaz Lake. We undoubtedly will receive some benefit from their storage in the form of return flow from Mason Valley. This being the first year of storage it is rather difficult to say just what benefit we will receive, but we intend to make observations and get all the data we can this year.

CROP REPORT, WALKER RIVER PROJECT

On Walker River there is a slight decrease in acreage from that of last year. This was due almost entirely from the river overflowing its banks in several places. A good many of the younger Indians would like very much to farm their allotments but under the circumstances we discourage them until we have assurance of a better water supply.

There are 92 Indian farmers on this project and 2 white farmers.

Crops are doing very well this year; the first cutting of alfalfa is going to average very nearly 2 tons per acre.

The Indian farmers had a very good year last year (1921), considering prices in general. They disposed of two-thirds of their hay crop at $14 to $15 per ton while the remainder was sold to sheepmen at $6 per ton in the stack. Their wheat crop was used for feed for poultry and for their season's supply of flour. The sale of poultry is getting to be quite an item in itself. One Indian sold 110 turkeys last Thanksgiving and received $328 in return. There are about 30 acres of potatoes planted this year, which is ordinarily the big money crop in this section. The farmers in the upper valleys raise from 8 to 16 tons to the acre. The soil on this project is as good or better than elsewhere in the Walker River Basin, so there is no reason why potatoes should not do well here. The average price for potatoes last year was $35 per ton.

[From 1924 annual report, Walker River project]

Water supply.—The water supply during July, August, and September, 1923, was very good, but this season has been very short; the supply being exhausted entirely on June 15. There is sufficient water in the river, but the whites are taking everything, leaving us high and dry. We are supposed to have the oldest right on the river, but that has been of no benefit to us so far.

Recommendations and needs.—The greatest need at Walker River is an early settlement of the water rights. The land in the Walker River Basin far exceeds the water supply, and if we do not get our land under cultivation before the white men we are going to have trouble.

The extreme shortage of water this season shows the need of storage. This may not be needed for several years, provided our rights are determined to be the oldest on the river, but as our project develops we will eventually reach the point where our requirements will exceed the low-water flow of both rivers. We have kept records of the flow this year and on our last run of water from Mason Valley we had nearly 60 second-feet of water at Parkers and the largest flow at our diversion dam was 23 second-feet. Parkers is 18 miles above our dam. This shows the big loss in dry weather.

The Indians are going to be hard hit this year by the drought regardless of what we do to get water for them. The white man will be just as bad off, so there will be little work for the Indians. This condition is going to cause much hardship and instead of doling out rations—the usual procedure—it is recommended that we endeavor to obtain a special appropriation to complete lateral A, canal No. 2, or build a canal for the allotted lands above our project.

[From 1925 annual report]

History and general conditions.—As previously reported, the season of 1924 was one of great misfortune and hardhship for the Indians of this reservation as a result of the failure of the water supply. No water was available after June 15, and practically all the crops, except the first crop of alfalfa and some gardens, were, in consequence, a total loss. So acute was the drought that it is estimated the Indians lost 200 head of their cattle, and a greater number were sold as a result of conditions. The value of the crops lost is variously estimated at from $40,000 to $55,000, and the resultant physical suffering and discomfort were, of course, great. Far worse, however, than the monetary loss and the physical suffering caused by loss of crops and stock incident to the lack of water is the discouragement and disappointment that will cause many of these Indians to abandon their farms, and the lessons of industry and self-reliance that the Indian Service has for many years, and at considerable expense, labored ceaselessly, and in this case with considerable success, to instill, will in a large measure be lost, as many of the Indians will doubtless revert into habits of shiftlessness, laziness, and beggary.

As a result of extensive irrigation developments, including extensive irrigation systems and storage reservoirs in the upper Walker River Valley, the water supply available for these Indians has been gradually diminishing from year to year and unless conditions are improved within a few years the water supply will, of course, fail entirely. The question relative to the water rights of the Walker River Indian Reservation has been before the United States attorney at Reno, Nev., in course of settlement for several months. It is not believed, however, that the adjudication of the water rights on the Walker River, even though such adjudication should result in the decree of all the water that can reasonably be asked for the Walker River Indians, will solve the problem of the water supply for the Walker River Indian Reservation. The loss of water through seepage as it is conveyed down the channel of Walker River is known to be excessive, and if the water users on that part of the Walker River lying above the reservation are required to pass a sufficient quantity of water for the irrigation of the Walker River Indians, thus standing the loss in transit, the result would probably be that a considerable area of land already developed by white water users may be left without a water supply. In other words, the loss of water in the river channel will be so great that it is believed necessary in the interest of the economical use of water to construct a storage reservoir as near the diversion works of the Indian project as possible. This question of the construction of a storage reservoir for the Walker River Indian Reservation has been under consideration for several years, but until recently no dam sites have been found that appeared feasible. During the season of 1924, however, a more thorough search has been made and two possible dam sites not heretofore considered have been found. Some preliminary investigation work has been done at each of these sites, and while conditions so far as disclosed seem to indicate the feasibility of them, it will be necessary to make further investigations involving the excavation of test pits and borings in the stream channel before the question of feasibility can be definitely settled and estimate of the cost of construction prepared.

[From 1926 annual report]

Water supply.—The waters of Walker River constitute the supply of this project, and though the flow during the fore part of the season has always exceeded the demand, considerable difficulty has been experienced during the latter half of the irrigation seasons in obtaining sufficient supply for the needs. Of late years the construction of storage reservoirs by the Walker River irrigation district, above the reservation, has served to regulate the flow of the river, but owing to the fact that no adjudication of water rights has ever been made, the water supply for the Indians is largely at the mercy of the white users above. This uncertainty has worked a hardship on the Indian farmers, especially in 1924, when about 400 acres additional land was put in cultivation and the crop and seed lost on account of inability to obtain sufficient water. In 1925 the supply

was ample for all needs, encouraging many to attempt to bring more new land under cultivation. The water supply for this season was sufficient up to June 14, but conditions indicate a serious shortage for the remainder of the season. Efforts have been made by the foreman in charge, to induce the white users above to release enough water to take care of the needs of the Indians, but to date has proved futile.

In 1924 and 1925, surveys were made to determine irrigation data for use in the suit instituted for the purpose of adjudicating the water rights of the Indians, but to date no decision has been rendered. The satisfactory settlement of water rights will not, however, solve all the water supply problems on this reservation, as the natural flow of the river is insufficient for the full development of the project without storage facilities by which the early run-off could be conserved. Investigations and surveys for storage possibilities were made during the years of 1918 to 1921, and further surveys were made of possible reservoir sites in conjunction with the adjudication surveys in 1924 and 1925.

From all of the foregoing, it is plainly apparent that the Indians have suffered considerably from the lack of a late season water supply and that efforts to promote their agricultural development has been greatly hampered by past irrigation difficulties and water supply deficiencies. Chief Engineer Code's report in 1906 indicates that apparently some action on the part of the United States in participating in the suit, Pacific Livestock Co. *v.* T. B. Rickey et al., instituted in 1902 and terminated in 1919, by decree No. 731, was contemplated. It is unfortunate that all water rights of the entire Walker River Basin were not established by this decree.

The immediate need for storage will depend largely upon the outcome of the suit now pending before the United States District Court of Nevada, United States *v.* Walker River Irrigation District et al. (in equity, C–125), in which the United States seeks to establish for the Indians a vested right to 150 second-feet of the waters of Walker River and tributaries thereof, with November 29, 1859, as date of priority, and to determine the relative rights and priorities of users in California who were not parties to decree No. 731. This suit was instituted in June, 1924, after various unsuccessful attempts on the part of reservation and irrigation officials to secure water for the Indians that year, and was largely precipitated by the remarks of the president of the board of directors of the Walker River irrigation district, to the effect that "the Indians had no rights, never had and never would get any, and that there was no occasion for granting any further concessions." (See letter of January 2, 1926, from Supt. G. A. Trotter to Commissioner of Indian Affairs.) At this time, Mr. J. A. Beemer, chief engineer for the Walker River irrigation district, was also water commissioner on the Walker River, appointed by the United States district court to distribute waters under decree No. 731.

Realizing that the water supply for that year (1924) would be extremely short and that under the existing conditions on the river there would be very little water for the reservation, Supervising Engineer Engle and Superintendent Trotter advised the commissioner on April 4, 1924, of conditions, and urged that immediate action be taken to insure a water supply for the year and to protect the rights of the Indians.

The matter was presented to the United States Attorney General on June 11, 1924, who immediately wired the United States district attorney to take whatever action was necessary to secure water for the Indians. It appears, since the United States was not a party to

decree No. 731, that the United States attorney was doubtful whether anything could be accomplished unless suit was filed by the United States to establish the rights for the reservation.

Following are copies of telegrams and correspondence regarding the subject:

[Telegram]

RENO, NEV., *June 12, 1924.*

SUPERINTENDENT WALKER RIVER INDIAN RESERVATION,
Schurz, Nev.:

Attorney General directs that I consult you and take whatever action necessary to secure irrigation water. Please advise.

UNITED STATES ATTORNEY.

DEPARTMENT OF JUSTICE,
OFFICE OF THE UNITED STATES ATTORNEY,
Reno, Nev., June 13, 1924.

MR. BEEMER,
Walker River Water Commissioner,
Yerrington, Nev.

DEAR MR. BEEMER: I have instructions from the Attorney General of the United States promptly to take whatever action is necessary to secure irrigation water for the lands on the Walker River Indian Reservation. I have gone over and the matter very carefully with Mr. Trotter, superintendent of the reservation, Mr. Kronquist, irrigation engineer, and have been informed by them that some days ago they expressed themselves to you as being satisfied, in view of the great shortage of water, with a minimum of a continuous flow of 22 second-feet, if it should be delivered to the reservation during the remainder of the irrigating season. Superintendent Trotter says there is some difficulty complying with this request, because the farmers do not understand the situation and are not aware of the legal rights of the United States so far as Indian reservation lands are concerned.

For your information, Indians and United States soldiers began the irrigation of lands in the Walker River Indian Reservation during the year 1858 on what is now known as the Walker River Indian Reservation. The reservation was set aside and reserved to the Indians in the year 1859. Inasmuch as the earliest rights on the part of the white men did not accrue until the year 1860, as shown by the court decree of the United States District Court for the District of Nevada, made and entered in the year 1918, in a proceeding to which the United States was not a party, it is clear that lands on the Indian reservations have first rights to the use of water. If the Government should insist upon it, undoubtedly all the water of the Walker River and all of its tributaries, including both the East and West Walker, could be taken during this year by the Government for use on the Walker Indian Reservation lands. That, however, would work such a great hardship on white farmers that, unless compelled to do so, the Government is not disposed to stand upon all of its rights. The minimum of 22 second-feet would serve only for necessary and beneficial irrigation of gardens and some grain lands, and one irrigation for the second crop of alfalfa. By limiting itself to that amount the Government would lose many thousands of dollars in crops, but even so, the superintendent believes that, under all circumstances, it is advisable to yield in part to the suffering farmers who have water rights much later in time to those of the Government on the Indian reservation.

I would appreciate it if you would inform Superintendent Trotter forthwith, and would also inform me, whether or not you can arrange the delivery of 22 second-feet. If you can not make such an arrangement, we would like to know it at as early a date as possible.

In the event you desire any information as to the rights of the Government, or in the event any of the farmers concerned desire any data, either Mr. Trotter or I will be glad to give the details.

Very truly yours,

GEORGE SPRINGMEYER,
United States Attorney.

YERINGTON, NEV., *June 14, 1924.*

Mr. GEORGE SPRINGMEYER,
United States Attorney, District of Nevada,
Reno, Nev.

DEAR MR. SPRINGMEYER: Your letter of the 13th instant relative to the need of water on Walker River Indian Reservation has been received.

The water rights of the reservation have never been determined, according to any information I have been able to obtain. I would, therefore, greatly appreciate it if you will furnish the detailed information mentioned in the last paragraph of your letter. Please advise me also whether I am authorized, as Federal court commissioner, to deliver this water.

(Copy to Mr. G. A. Trotter, superintendent Walker River Indian Reservation, Schurz, Nev.)

Very truly,

JOHN A. BEEMER, *Water Commissioner.*

RE WALKER RIVER RESERVATION WATER RIGHTS

OFFICE OF THE UNITED STATES ATTORNEY,
DISTRICT OF NEVADA,
Reno, Nev., June 20, 1924.

Mr. G. A. TROTTER,
Superintendent Walker River Indian Agency,
Schurz, Nev.

DEAR MR. TROTTER: Your letter of June 17 with inclosure:

I am glad to have your statement to the effect that you are quite sure the water commissioner will furnish water for irrigation of the second crop of alfalfa, provided he receives authority to act and the river does not fail entirely before that time. As you say, this would of course carry out the terms of the verbal agreement, and there would be no necessity for court action.

I have sent Mr. Beemer a copy of the records showing the request for the setting aside of the Walker River Indian Reservation in 1859, and I have written that it is my opinion he should deliver whatever waters the Indians on the reservation are entitled to receive to them. I am wondering whether Mr. Beemer feels he should have authority of court. If so, there may be some difficulty. I hardly know how to proceed, because the United States is not a party to the suit in which he is the commissioner. I wish you would, if possible, ask him about this and learn whether or not he is satisfied to act upon my opinion, or whether he will require something further.

Very truly yours,

GEORGE SPRINGMEYER,
United States Attorney.

WALKER RIVER INDIAN AGENCY,
Schurz, Nev., July 16, 1924.

COMMISSIONER OF INDIAN AFFAIRS,
Washington, D. C.

DEAR SIR: The following is a report on the water situation on the Walker River Reservation and the action taken with reference to securing relief for the Indians.

On June 12 a telegram was received by me from the United States attorney in which he advised that the Attorney General directs for me to consult with him and take whatever action necessary to secure irrigation water. I wired him that I would consult with him in Reno the following day.

In company with Mr. Kronquist, the irrigation foreman located here, I went to Reno on June 13 and talked the matter over with the United States attorney. Mr. Kronquist, who has been handling the water situation at this place for several years and was in close touch with Mr. Beemer, the water commissioner, as well as myself, were of the opinion that a letter from the United States attorney showing the rights of the Indians would be sufficient for him to act and allow us water for one irrigation.

Accordingly, the United States attorney addressed Mr. Beemer with relation to the rights of the Indians, a copy of the letter being inclosed. In reply to this letter, Mr. Beemer, on June 14, 1924, wrote the United States attorney. (See preceding letter.)

I received no carbon copy of the letter from the United States attorney to Mr. Beemer but am inclosing copy of letter from Mr. Beemer to Mr. Kronquist and myself with quotation from this letter. This letter was dated June 19. Mr. Kronquist and myself both talked with Mr. Beemer and found that he would do nothing without a direct order from the Federal court.

As Mr. Kronquist had business in Reno, he consulted with the United States attorney, and on June 21, 1924, he called me by telephone and advised me that the United States attorney had requested me to wire your office for certified copies of order of November 29, 1859 for use in bringing suit for the purpose of determining the rights of the Indians. In this telephone message Mr. Kronquist advised me that the United States attorney wished for me to secure a list of all water users on both East and West Walker River, as it was necessary for all to be enumerated in bringing this suit.

I secured the lists from the records at Bridgeport, Calif., and Yerington, Nev., and mailed same to the United States attorney on June 25, 1924. On June 28, 1924, I received a letter from the United States attorney, as follows:

"Your letter of June 25. This will enable me to prepare the necessary pleadings. I hope, however, that it will not be necessary to take this action, and I am anxiously awaiting word from you as to any change in attitude on the part of the water commissioner. Of course, if you are not receiving the water to which you are entitled, any other plan than to file suit might not properly be followed.

"As soon as you get the certified copies of the orders from Washington, please send them to me and advise me definitely as to the necessity for suit."

The above letter was dated June 26, 1924.

On receipt of this letter, I wired the United States attorney as follows:

"Your letter 26th. Requested certified copy order mailed you direct. No chance change attitude water commissioner. Unless immediate action taken crops will be burned up."

In answer to the above the United States attorney wired for Mr. Kronquist or myself to come to Reno July 1 to assist in drawing papers and stated that the matter would be presented in court on July 3 and to bring witnesses on that date. As I was ill when the message was received, Mr. Kronquist appeared on July 1, and on July 3 a restraining order was issued by the court allowing 12 second-feet of natural flow of water for the Indians of the reservation.

The restraining order was returnable on July 10 and on that date we appeared, as did the drainage people with their attorneys. The judge, when he found a disposition on the part of the attorneys to contest the case and not allow one irrigation for the present year which was all we were asking, advised that some agreement should be entered into in order that some relief could be furnished the Indians.

After the United States had presented evidence and had rested, a recess was called in order that some arrangements could be made by which some relief could be given the reservation without working too great a hardship on the upper river water users.

In the meeting arranged between the United States attorney and the Indian representatives with the attorneys of the water users, it was agreed that water should be stored in the Topaz Reservoir for a period for five days. That water from the East Branch of the Walker River should be allowed to flow down the bed of the river for a like period, thus priming the river bed and giving more assurance of a sufficient amount to be delivered at the headgates on the reservation to be of benefit.

There was some difference of opinion among the attorneys as to the jurisdiction of the Federal court of the Nevada district extending over the portion of the drainage basin in California, but the United States attorney claimed jurisdiction in a case where the United States Government was a party, and papers were served on the California users by the United States marshal from California.

In the court order containing the provisions of the agreement entered into, the water commissioner at Yerington was to handle the irrigation for the district with the assistance of the irrigation foreman, Mr. Kronquist. The matter is now being arranged for the delivery of the water as noted, and it is hoped that some benefit may result, although I am of the opinion that it is too late to be of benefit for any of the crops with the exception of a second crop of alfalfa.

A report will be made covering the delivery of the water and the results obtained as soon as this irrigation has been made. The attorneys for the water users on the upper river have made the claim that the natural flow of the river has fallen so low that this attempt to send water to the reservation as arrangements have

been made will be useless. This can only be proven by actual experiment and even if the crops are not benefited, stock water will be supplied for a time.

Very truly yours,

C. A. TROTTER, *Superintendent.*

Under decree No. 731 certain rights for the reservation were allowed by Special Master Henry Thurtell, as follows:

1868, 4.70 cubic feet of water per second for 385.95 acres.
1873, 3.55 cubic feet of water per second for 295.80 acres.
1875, 6.15 cubic feet of water per second for 512.80 acres.
1883, 7.50 cubic feet of water per second for 625.20 acres.
1886, 1.03 cubic feet of water per second for 85.80 acres.

Under conditions such as existed during the years 1924 and 1926 these findings would be of no value during the months of July, August, and September, as priorities of 1867 or earlier could not be supplied by the normal river flow. (See Table III, p. 31.)

Regarding the question of Indian rights and the necessity for complying with local formalities and laws, the following departmental letter on the subject, is offered as explanation:

DEPARTMENT OF THE INTERIOR,
OFFICE OF INDIAN AFFAIRS,
Washington, December 2, 1920.

MR. JAMES E. JENKINS,
Superintendent Walker River School.

MY DEAR MR. JENKINS: The office is in receipt of your letter of November 17, 1920, inclosing notice from the State engineer of Nevada relative to proof of beneficial use of water to be used for irrigation purposes on the Walker River Reservation.

In the absence of legislation by Congress the lands and water rights belonging to Indians within Indian reservations are not subject to the operation of State statutes. As a matter of law, therefore, the Indians or the Indian Service representing the Federal Government can not be compelled to comply with State statutes relating to the acquisition of water rights. As a matter of comity or courtesy to State officials, however, it has been the practice to at least advise such officials of the rights of the Indians in order that due notice may be had thereof in adjudications by State officers of water rights pertaining to lands in white ownership. The actual filing of an application for permit pursuant to State statutes is not necessary and appears to have been undertaken through a misconception of the situation with reference to matters of this kind. Your action in partly filling out the blank form showing proof of beneficial use, while not absolutely necessary in order to protect the water rights of the Indians, was not at least improper, in that it is not seen how any direct injury will result therefrom. The chief difficulty in matters of this kind is the impression created in the minds of State officials and others that compliance with the State law, or attempts to comply with such law, is an admission that the State and State officers have jurisdiction over the matter involved therein. If it is thoroughly understood that such officers have no positive jurisdiction over the Indian water rights but that the endeavor to comply with the State statutes is merely for the purpose of notifying State officers and the public at large of the claimed rights of the Indians, the proceedings had in such endeavors to comply with State statutes would simply make of record the rights of the Indians in the premises. Your action in declining to remit the filing fee required by State statutes was perfectly proper under the circumstances. Neither your letter of the 17th nor the inclosures attached thereto disclose the acreage on which proof of beneficial use of water was attempted to be proven under the permit previously filed. Such information could have well been given, but it should be understood that the failure of either the Indians or any one connected with the service to offer proof of beneficial use within the time required by State statutes will in no way jeopardize the rights of the Indians under these circumstances, these property rights of the Indians not being subject to the laws of the State.

Very truly yours,

E. B. MERITT,
Assistant Commissioner.

In view of the serious situation threatening damage and loss of crops for the Indians then existing, and the necessity of forcing recognition on the part of white water users along the river of the rights of the Indians, it was deemed necessary to establish these rights by appropriate action in the Federal courts. Accordingly, the action—United States *v.* Walker River Irrigation District et al. (in Equity C–125)—was filed, and a temporary restraining order obtained on July 3, 1924, and the preliminary hearing set for July 10, 1924. A stipulation as to rights and river operation, pending the issue of a final decree by the court, was drawn up and approved by the court on July 11. The water commissioner made an attempt to deliver water according to stipulation, but was unsuccessful because of the impossibility of controlling water in the river under the conditions of diversion and lack of suitable head gates along the river which could not be locked; and being an employee of the district, it is believed was somewhat reluctant to enforce any drastic measures that might antagonize his employers and jeopardize his position with the district.

As a consequence, the crops of the reservation suffered considerably, and many were a total loss, there being no water available for irrigation after June 15, 1924. The terms of the original stipulation were unfavorable to the United States, and it was not until September, 1925, after several stipulations had been proposed, that terms acceptable to all parties were finally accepted.

Briefly, the stipulation provides that the priorities of those rights, which have been adjudicated and set up in decree No. 731, shall be made a part of the final decree and be placed in what is known as Schedule A. Schedule B will consist of those rights which have not been determined, viz, those of the Government for the Indians and the lands in California.

Action on the part of the United States attorney was slow, and progress in the case would have been delayed had not the present season (1926) been very similar to 1924. Attempts to secure water for the reservation in 1926 were unsuccessful, and the several commissioners on river distribution failed to enforce the stipulation of the court. The resignation of the United States attorney in the middle of the season delayed action. In order to further hasten action Mr. Cole L. Harwood, of Reno, Nev., was appointed special assistant to the Attorney General to act as counsel for the United States and to have immediate charge of the prosecution of the case under the general supervision of Mr. Ethelbert Ward, of Denver, Colo., whose time and attention was so required for numerous other cases of the Department of Justice that he was unable to look after the legal details involved in the Walker River case; under this personnel an early settlement is promised. The "Amended bill of complaint" was filed March 19, 1926, and the "Bill of particulars" on October 19, 1926.

The river above the reservation was completely dry from July 26 to October 29 of this year (1926), and it was only by constant effort that water for Indian livestock was then secured, the Indians being entirely without water for irrigation or livestock from July 26 to October 29.

Various assumptions and statements have been made by opposing interests regarding river losses and return flow, but these are entirely without foundation, as no systematic measurements or studies have been made by the water commissioners to determine these. Proposed investigations along this line have been opposed by the Walker River irrigation district because of the added expense to river distribution.

It is hoped that the Federal court, will, for the coming season, appoint a competent water master to distribute the waters of the river and make such measurements and studies as are necessary to determine transmission losses and the dependable increments of return flow that might increase the general efficiency of the river.

It is not believed that the adjudication of the water rights on the Walker River, even though such adjudication should result in the decree of a reasonable amount of water for the Walker River Indian Reservation, will solve the problem of the water supply for all time. What the final decree of the court will be in the pending case can not be predicted. It is also very probable that rights will be defined with certain limitations, depending upon the beneficial use of water.

With the recommended final decree of the court in the near-by Truckee River case—United States *v.* Orr Ditch Co.—in which the Pyramid Lake Indian Reservation lands are granted water with the first priority as of 1859—as a precedent, it is assumed that the Walker River adjudication will result in a similar decree. In accordance with this decree they would not be entitled to divert the full amount decreed but only a proportionate quantity, based upon the actual area in cultivation. On this basis, in ordinary years it is not likely to seriously deplete the river to the detriment of whites in the valleys above, but in years of extreme drouth, such as 1924 and 1926, and with only a slightly increased area over the present irrigated area, a similar decree would entitle the Indians to the greater part of the entire river flow in the late season months.

It is entirely probable that certain rights of settlers and white water users in the valleys above the reservation, who settled upon and developed these lands in good faith, laboring to provide themselves with homes, and whose efforts have further increased the resources of the country, will apparently be entitled to some recognition.

It is plainly manifest that if all of the present irrigable area of the Walker River Basin is to be irrigated and cultivated, that more storage is required, particularly if the Walker River irrigation district consummate the plans for irrigating their entire irrigable area of 165,000 acres upon which the apportionment of benefits of present storage development expenditure has been made. If the courts establish rights upon the principal of beneficial use, and on the basis of the general welfare of public interest and society as a whole, it is doubtful whether the Indians could continue to hold a full right for all lands with the earliest priority. It apparently would be unjust to confiscate or deprive the early white settlers of water rights developed by the long use of water in the establishment of homesteads and by the continued cultivation of lands they have reclaimed. It is also unjust to permit the continued expansion and development of lands to the detriment of the patient Indian, who, naturally lacking the agricultural and land-development instinct, has been less aggressive

and ambitious in making use of waters available. The doctrine of beneficial use, and the greatest economic use for the general public welfare, should not permit the continued excessive use of water by large corporate interests whose wasteful and extravagant methods of use are water-logging large areas of land, rendering it unfit for intensive agricultural development and greater returns.

That there are return flows, and increments to the river flow from subsurface percolation and seepage, is not denied, but measurements and investigations of river to determine these are so few that no definite conclusions may be established or reliance placed upon these in determining the water supply available from this source. It is also questionable whether these increments offset canal seepage and transmission losses as stated in other investigations and reports on the Walker River water supply.

From the standpoint of public interest, the fullest and most economical use of the water supply will be obtained by the construction of a reservoir below Mason Valley, and above the reservation lands. Lower Mason Valley must ultimately of necessity be drained, and this increment to the river utilized and conserved. The characteristic flood run-off of the river occurs generally during June, and with the ultimate development of all storage sites in the higher watersheds, there will be considerable run-off from lower watersheds that can not be utilized unless conserved by storage on the lower reaches of the river. The lower reservoir is needed for conserving bank storage—that is, the increment to stream flow derived from the slow return during the late season, of water filling the sands and subsurface voids in the immediate river flood plains during high water, or periods of maximum flow. This return flow occurs sometimes so late in the season that it can not be utilized for irrigation.

Under conditions existing during 1924 and 1926, when the stream run-off was extremely deficient, the entire normal flow of both the East and West Walker Rivers, neglecting the factor of return flows and other increments, during the months of July, August, and September, would be required to irrigate the present area in cultivation on the reservation. The reservation diversions are approximately 100 miles from the main source of supply and carrying this small quantity of water in a large river bed would result in considerable loss, especially in the section of river between the last Mason Valley diversion and the reservation diversion. During July and August the loss by evaporation alone is quite noticeable; the river bed consists entirely of shifting sands and the small quantity of water required for the reservation spreads out in the river channel to a considerable width, and on an average of less than a foot in depth. The reservation diversion is located so far from the source of supply that satisfactory service can not be maintained without some storage and reserve supply near the canal headgates, and points of diversion available for immediate release and irrigation demand.

The necessity of providing some storage for the irrigation of reservation lands is accepted, and more especially is it required if all irrigable Indian allotments are to be irrigated and cultivated. The ultimate total reservoir storage that will be required can not be definitely determined until it is known what rights to the normal river flow will be established for the Indians in the present water adjudication suit now pending before the United States district court.

It is very essential that certain normal flow rights or priority of appropriation of natural stream flow during the irrigation season be established. The Walker River irrigation district has been granted by division of water rights of California permits to appropriate and store a total of 292,200 acre-feet of water from the East and West Walker Rivers, of which storage for 92,500 acre-feet has been developed. If the total development is carried to completion, or construction begun by the district on permits for the Leavitt and Pickle Meadows Reservoirs by August 1, 1927, the entire average surplus run-off of the river will be appropriated, and the reservation left dependent upon uncertain return flows and the intermittent run-offs of lower watersheds. The tables on the following page, while not complete, give the annual run-off of the river at the Wabuska station, which is below all Mason Valley diversions and above the reservation. The figures indicate the run-off available for use on the Walker River Reservation. The Schurz station gives the run-off or annual waste into Walker Lake. During 1924, 1925, and 1926 less than 30,000 acre-feet each year was available for the reservation. If the district had the additional storage reservoirs contemplated in operation and priorities of appropriation enforced, there would have been no water available for the past three years for the Indians except what normal flow during the irrigation season was allowed to reach the reservation at the discretion of the river water commissioner.

Annual run-off by months—in acre-feet

BELOW ALL WHITE DIVERSIONS AND ABOVE RESERVATION

[From records of U. S. Geological Survey]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1904 [1]	11,668	7,183	8,054	6,727	18,937	36,977	21,833	7,024	1,493	10,243	6,936	4,554	141,629
1905 [1]	13,330	11,760	15,500	9,330	9,162	17,550	3,585	400	120	130	890	2,760	84,517
1906 [1]	[2] 11,668	[2] 7,183	[2] 8,054	[2] 6,727	29,960	52,920	84,500	25,235	4,030	[2] 4,030	[2] 1,000	[2] 2,760	238,067
1907 [1]	[2] 13,330	[2] 11,760	[2] 15,500	[2] 9,330	[2] 29,960	38,000	63,000	15,000	[2] 4,030	[2] 10,243	[2] 6,936	[2] 4,554	221,643
1920 [3]	5,320	4,620	4,640	904	5,740	12,800	3,190	544	365	598	4,980	9,100	52,799
1921 [3]	10,800	11,200	9,220	881	5,730	17,900	5,770	437	232	428	1,320	4,340	68,255
1922 [3]	5,320	10,400	7,130	17,600	49,900	102,000	45,800	2,780	803	3,828	9,060	12,300	260,921
1923 [3]	7,076	7,400	12,172	13,111	16,000	20,000	13,912	5,044	11,164	14,000	9,520	8,300	137,789
1924 [3]	[4] 7,690	[4] 8,630	[4] 3,070	[4] 595	[4] 369	[4] 298	[4] 123	0	0	0	0	0	20,775
1925 [3]	210	130	1,290	964	2,720	2,020	3,600	6,760	2,220	3,220	2,660	1,990	27,784
Mean	8,641	8,036	8,463	6,617	16,848	30,046	24,531	6,322	2,446	4,672	4,330	5,066	126,018
Mean flow [5]	141	143	138	111	274	502	400	103	41	76	73	83	-------

[1] Station located 300 feet above railroad bridge of S. P. Tonopah Branch R. R.
[2] Estimated.
[3] Station located on Parker ranch 1 mile below railroad bridge.
[4] Monthly reports completed by U. S. Geological Survey estimates.
[5] Second-feet.

BELOW RESERVATION DIVERSIONS—SHOWS RUN-OFF INTO WALKER LAKE

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1914	36,700	26,700	33,300	57,500	92,200	115,000	68,900	22,300	3,290	1,480	9,160	13,800	480,330
1915	12,300	13,600	15,200	14,500	18,400	42,700	33,200	670	289	8,732	15,100	11,300	185,991
1916	15,100	28,800	33,300	43,500	43,400	56,100	39,900	1,840	109	2,300	5,360	12,300	282,009
1917	16,700	10,200	17,300	27,700	37,000	73,800	52,000	2,920	62	13,300	16,800	16,600	293,382
1918	9,160	8,890	14,800	14,700	7,070	59,000	6,400	61	30	350	7,200	9,280	136,941
1919	3,950	[2] 8,890	[2] 3,000	16,000	40,600	25,400	31	31	30	11,000	12,900	14,100	145,832
1920	8,480	5,020	1,650	0	3,040	6,720	2,400	0	0	0	1,420	8,480	37,210
1921	10,100	9,890	2,690	64	1,270	10,500	1,720	42	42	0	512	1,410	38,240
1922	2,780	7,160	7,560	17,600	40,500	94,000	47,300	676	184	2,156	7,444	12,100	239,460
1923	8,512	8,244	12,064	10,218	11,400	17,516	9,722	252	6,970	13,300	8,810	7,690	114,698
1924	7,750	8,220	2,980	333	148	42	0	0	0	0	0	0	19,473
1925	178	0	0	0	350	0	861	3,840	190	[2] 3,000	[2] 2,660	[2] 1,990	13,069
Mean	10,976	12,051	11,154	16,918	25,365	41,732	21,870	2,719	933	4,636	7,277	9,087	165,553
Mean flow, second-feet	179	206	182	284	413	701	356	44	16	74	123	148	-------

[2] Estimated.

The total water supply annually required for the irrigation of the present allotted area of 10,060 acres, assuming a duty of 3 acre-feet per acre at the land, or a gross duty of approximately 4.5 acre-feet per acre, will be approximately 45,000 acre-feet, plus reservoir losses.

Opinions as to the duty of water in the Walker River Basin are quite variable, and an exact duty has not been seriously considered because of the large percentage of return flow assumed, wherein the actual irrigation capacity of the stream is assumed as being much greater than the apparent capacity. While several engineers in reporting on the Walker River water supply have assumed the duty of water at 3 acre-feet per acre gross, it is doubtful whether this figure has been attained. The irrigation season is generally from April 1 to October 1, or a season of 180 days. While in some years very little water is required during April and the latter part of September, some irrigation is necessary for forage crops and pasture.

The following duties of water have been used in the various reports on the subject, with the theoretical use by months as shown:

Duty of water, acre-feet per acre per year

Month	J. C. Stevens's report, 1015, at diversion	J. A. Beemer's report, 1022, at diversion	L. A. Palmer's report, 1922, at land	Recommended for reservation at land
April	0.30	0.24	0.21	0.20
May	.54	.54	.47	.40
June	.66	.72	.62	.75
July	.66	.78	.67	.90
August	.60	.54	.47	.60
September	.24	.18	.16	.15
Total	3.00	3.00	2.60	3.00
At diversion (acre-feet)	----------	----------	----------	4.50

The Stevens report assumes a net duty of 2 acre-feet per acre at the land, or 3 acre-feet gross at river diversion. The Beemer report also assumes a gross duty of 3 acre-feet per acre at river diversion, but with

somewhat different monthly use. The Palmer report is the net duty at the land, and assumes that transmission losses are balanced by return flows and apparently amounts to a gross diversion of 3 acre-feet, or more, at river diversion. The Nevada water law has fixed the gross duty of water for general use throughout the State, at 100 acres per second-foot continuous flow, amounting to 3.6 acre-feet per acre for the six months season. Under decree No. 731 the court granted some rights for as much as 1.6 second-feet per hundred acres, which on a continuous flow basis, will amount to 5.7 acre-feet per acre per season of 180 days.

Our experience in Idaho and Utah would indicate that maximum use in June and July is considerably greater than that assumed in the above reports, and no doubt diversion on the Walker River in the upper valleys has far exceeded that assumed, because of great return flows assumed and moreover, because the actual net area irrigated is considerably less than figures reported, or the areas under decreed rights. From the casual examination made of Walker River irrigation, it is believed that actual river diversion for the net area irrigated would be nearer 5 acre-feet per acre than 3 acre-feet. Past operation experience indicates that transmission and evaporation losses are large in the lower Walker Lake Valley. There are no return flows in the valley to supplement the river flows, and it is believed that a gross duty of 4.5 acre-feet per acre at river diversions for the reservation lands is very conservative.

STORAGE FOR RESERVATION LANDS

In the report of Engineer J. A. Beemer, of March 25, 1920, the following plans for obtaining a supplementary water supply for the Walker River Indian Reservation, were proposed:

(1) Storage on reservation.
(2) Alkali Lake storage.
(3) Leavitt Meadows storage.
(4) Bridgeport Meadows storage.
(5) Twin Lakes storage.
(6) Drainage of Mason Valley lands.
(7) Lowering river bed to drain Mason Valley lands.
(8) Awaiting development of the district and using run-off from irrigated lands above the reservation. (Copy of report in appendix.)

Storage on the reservation is now considered the most feasible and practicable plan and will be discussed in detail subsequently. Storage has already been developed under plans 2 and 4 by the Walker River irrigation district in the construction of the Topaz (formerly Alkali Lake) and Bridgeport Reservoirs. The district has permits pending for the development of the Leavitt Meadows and Twin Lakes storage sites in addition to the development of storage at Pickle Meadows on West Walker River, not named above, under plans 3 and 5. These reservoir sites are all located at or near the headwaters of the Walker River and from 60 to 100 miles from the reservation diversions. They are too distant for efficient regulation and control and under the present system of river regulation the transmission of water released would be very uncertain, troublesome, and expensive.

The drainage of Mason Valley lands, with the improvement of the river channel and the water supply available from return flows and

wastes from the district lands, are propositions that would not justify expenditure by the United States. The results to be derived from such proposed work would be very uncertain. The lands of lower Mason Valley must ultimately of necessity be drained or they will be worthless for agriculture. The return flow from this source and wastes from irrigation of district lands when they enter the river channel again, constitute normal river flow subject to public regulations and will be available to those best situated to beneficially use them, thus increasing the general efficiency and scope of the whole river water supply from which all rights will be benefited. This development, which will gradually be attained in improved river administration and the reclamation of lands concerned is entirely outside the province of the United States in seeking an additional water supply for reservation lands.

Storage on the reservation is recommended for the following reasons: First, the reservoir would be near the land to be served, which would facilitate regulation and delivery; second, the expense of operation and maintenance would be less than on a reservoir located at a considerable distance from project lands; third, a reservoir on the reservation would result in the conservation of the general water supply of the entire river and a better utilization of return and seepage flows. Water that might otherwise waste into Walker Lake can be conserved for irrigation use. A reservoir on the reservation or below Mason Valley will increase the general efficiency of the river water supply and a much higher apparent duty of water obtained.

WEBER RESERVOIR SITE

The site of the dam proposed in the Beemer report, known as the Weber site, is located about 9 miles above Schurz, and 2½ miles above the diversion dam for the present irrigated area of the project in the lower valley. This site has been thoroughly investigated and tested. The several dams proposed in the Beemer report were 40 feet in height above the river bed, elevation 4,180, and the maximum storage of the reservoir, with a water surface elevation of 4,212, was 9,600 acre-feet.

The estimated costs of proposed dams were as follows (details of plans and estimates of Beemer report in Appendix C):

Earth-fill dam, estimated total cost	$110, 000. 00
Cost per acre-foot of storage	11. 48
Earth-fill dam, with siphon spillway	100, 000. 00
Cost per acre-foot of storage	10. 42
Concrete dam, estimated total cost	120, 000. 00
Cost per acre-foot of storage	12. 50

Spillway capacity, 6,600 second-feet.

The above estimates do not provide for payment to Indians for approximately 500 acres of allotted irrigable lands that would be flooded.

The Weber site was not considered satisfactory because it is below the allotted irrigable lands—an area of 3,000 acres—in the upper valley of the project which would not be benefited by the proposed reservoir. The conditions for a spillway are unsatisfactory, there being no natural rock cliffs or outcrops suitable for a spillway, or overflow for surplus flood waters. The cost of providing a spillway

of sufficient safe capacity has been underestimated in the above report. It is also doubtful whether suitable material for an earth embankment can be obtained and placed for the unit cost of $0.35 per cubic yard, as estimated for this site. The storage capacity is limited and the probable unit cost per acre-foot of storage would be comparatively high.

The river through the entire reservation was explored, with special effort to find a suitable dam site above all reservation irrigable lands. In 1924 two sites were found, and brief examinations made of these in conjunction with the adjudication surveys of the irrigable lands on the reservation. The first, designated as the Parker site, is located in the SE. ¼ section 16, township 15 north, range 26 east; the second, known as the Rio Vista site, is in the SE. ¼ of section 30, township 15 north, range 27 east, approximately 4½ miles below the Parker site.

Further investigations of the three sites—the Weber, Parker, and Rio Vista—were made this year under the appropriation providing funds for this purpose, and from the studies made it was concluded that the Rio Vista site was the most practical development of the three. The Parker site, located farthest upstream near the northern and western boundary of the reservation, has excellent natural conditions, a rock outcrop on the south bank of the river, for a spillway, but the storage capacity from this development is limited to approximately 6,500 acre-feet. Increasing storage at this site would involve railroad relocation and reconstruction and the construction of an expensive embankment to prevent inundation of a considerable area of private lands to the west, including the town of Wabuska and the overflow of flood waters into the Carson River drainage area. Accordingly, detail investigations and surveys were confined to the Rio Vista site, which development is the basic subject of this report.

RIO VISTA RESERVOIR SITE

The construction of a dam at the Rio Vista site, in addition to the development of storage, will also serve as a diversion dam for the proposed canals No. 3 and No. 4, to irrigate the allotted irrigable area of approximately 3,000 acres in the upper or Campbell valley of the reservation. It is estimated that a suitable diversion dam for the future development of these lands would cost approximately $15,000. By the construction of a dam 55 feet above the river bed at this point, a reservoir of approximately 40,000 acre-feet capacity, with maximum water surface elevation at 4,295 will be developed. This development will incorporate in the reservoir basin the Parker Reservoir site, in which the proposed water-surface elevation for maximum storage was 4,296. The elevation of the river bed at the Rio Vista site is 4,245. A dam 40 feet high, or storage to elevation 4,275, will provide for storage of approximately 10,000 acre-feet, or approximately the same as a 40-foot dam at the Weber site, in addition to serving as a diversion dam for the irrigation of the upper area of project lands.

At the Rio Vista site there is a rock outcrop at elevation 4,295, over which a suitable spillway can be economically constructed. While the dam required at this site will be considerably longer than at the other sites, it is believed that favorable construction

advantages and conditions will very materially reduce unit costs of construction. There are ample quantities of construction material—sand and concrete aggregates, loose rock for riprap, excellent sand for gunite work and a variety of graded material probably suitable for an earth-fill dam on the site, which is approximately 1 mile from the railroad. Construction and labor costs should be considerably less than the average for this class of work, which is ordinarily remotely located at a considerable distance from railroads or improved highways.

At this writing, field investigations are not entirely completed, and studies of detail designs, comparative cost estimates and proposed methods of construction, are not sufficiently advanced to recommend any of the particular type of dam proposed, or accurate estimates of cost. A supplemental report on the result of studies of the various types proposed, with comparative detail cost estimates and recommended methods of construction, will later be submitted for the consideration of a consulting board, or for other appropriate action and departmental approval. However, it is believed that the data furnished in this report is a sufficient basis for taking some immediate action toward the provision of a better water supply for the Walker River Reservation, and for requesting an appropriation, which on this basis will be reasonably close to the ultimate cost of work proposed.

The surveys made consist of a plane-table topographic survey of approximately 4,500 acres in the proposed reservoir basin on a scale of one inch equals 400 feet; detail topography of the dam site on a scale of one inch equals 100 feet, and a general reconnaissance survey of the entire Walker River and watershed. The dam site was thoroughly explored, and subsurface conditions and formations were determined by digging open pits and shafts; diamond drilled and wash-bored test holes. In holes drilled by the wash-boring apparatus, satisfactory samples were secured from cores extracted from a pipe driven down into the material through the wash-bore casing. The samples thus obtained were mechanically analyzed by sieves and elutriation. Seepage, percolation, and rate of water flow tests were made by observing the rate of water percolation through a 1½-foot sample in a test tank under a constant head. The material underlying the river bed was also tested for rate of flow by attaching a pump to the casing, and pumping water into the material—the quantity, pressure at casing, and amount pumped being noted. The process was also reversed and water pumped out of the material. Under these tests the sand and clay mixture under river-bed sand disclosed a surprising degree of impermeability. Tests on materials for dam have not yet been made, as it was considered more important to determine foundation conditions first. There is a variety of suitable material for the embankment available, and by grading and selecting material the desired quality of fill can be obtained.

Because of the lack of bedrock for foundation and the length of dam required, it was concluded that the cost of construction of a concrete dam of any type would be prohibitive, and that the earth-fill type was the most economical and suitable for this site.

Test holes in the river bed indicate that the clay stratum that is found on either side of the river bed, is broken under the center of the river bed. The first 10 feet is the regular river-bed material com-

posed of a rather coarse sand; below this the sand becomes finer, with small quantities of silt and clay disseminated through it. At depths varying from 36 to 45 feet below the river bed and underneath this fine sand and clay is found clay and rock similar to the weathered andesite formation found on top of the andesite rock on the west side of the river. This condition exists a short distance above the axis of the proposed dam. Below the toe of the dam, nothing but sand of a varying character was found for a depth of 45 feet. From information so far available, it is probable that just above the axis of the dam there is an intrusive dike of andesite rock extending across and below the river bed from the rock hill on the west, to some similar rock outcrop on the east side of the river about 400 feet above the dam. However, it is believed that the expense of tying an impervious core to this probable reef would be excessive, and is not considered necessary for a dam of the height proposed.

As heretofore mentioned, tests and analyses of the fine sand with some clay found in this gap below the river bed indicate that it is more or less impervious, and that by connecting the impervious core or blanket in the dam well into this material by means of sheet piling the dam would undoubtedly be safe. The movement of percolating or seepage water below the dam would be very slow, and it is very improbable that piping or blowouts with sufficient velocity to move the sandy foundation material would occur.

In order that there might not be any concern as to the future safety and stability of the structure, several conservative designs of earth-fill dams are proposed, that use a higher coefficient of percolation than that of the material below the river bed. In order to secure the desired percolation gradient conforming to the assumed percolation coefficient, the path of percolation is increased by placing an impervious clay blanket on the river bed extending upstream from the toe of the dam. Another suggested design that is recommended by an engineer of wide experience and a recognized authority on dam design, proposes the use of a downstream blanket of rock fill to increase stability, and recommended as being very efficacious in preventing piping through a porous foundation.

Proposed Rio Vista Dam and estimated costs—Reservoir capacity and area table

Elevation	Area	Capacity	Elevation	Area	Capacity
	Acres	*Acre-feet*		*Acres*	*Acre-feet*
4,255	104	250	4,280	1,055	14,932
4,260	300	1,260	4,285	1,421	21,123
4,265	479	3,207	4,290	1,744	29,034
4,270	698	6,150	4,295	2,643	40,002
4,275	880	10,095			

There has not been sufficient time for the preparation of detail designs for the gate structure, outlet tunnel, spillway, and other minor accessory features of the dam. The proposed layout of these are shown on the general plan from which quantities were computed and estimates made, accompanying the drawings of this report. The estimated cost of proposed construction is based upon the following:

Storage capacity	acre-feet	22,000
Top of dam, elevation (55 feet above river bed)	feet	4,300
Spillway crest, 300 feet long, elevation	do	4,286

Spillway capacity	second-feet	23, 800
Outlet tunnel, minimum capacity	do	200

Tunnel section, reinforced concrete conduit, 7-foot horseshoe, 250 feet long.
Control gates, two 4 by 8 foot cast-iron sluice gates.

ALTERNATIVE ESTIMATES

Storage capacity	acre-feet	30, 000
Plan A:		
Top of dam, elevation	feet	4, 305
Spillway crest, elevation	do	4, 291
Plan B:		
Top of dam, elevation	do	4, 300
Spillway crest, elevation	do	4, 286

With gates and flashboard piers to raise storage to elevation 4,291 feet.
Other features same as above.

The spillway capacity is based upon a run-off of 10 second-feet per square mile for the drainage area of 2,350 square miles on the river above the dam site. This assumption is based upon the average of the maximum flood records of near-by rivers in Nevada and California, and that this probable flood run-off would have the same intensity over the entire watershed.

The maximum Walker River discharge on record is 5,000 second-feet at Coleville, Calif., and approximately 3,200 second-feet for about the same date at Wabuska, Nev. It is sometimes more economical under certain conditions where life and property are not concerned, to repair the damage resulting from a rare flood that may occur only once in a century; than to invest considerable capital to provide for these rare occurrences. This subject in the final design will require considerable study, as the failure of many earthen dams has been attributed to insufficient spillway capacity with the resultant overtopping.

Since there is but very small storage below elevation 4,255, the outlet tunnel is set at that elevation. The tunnel proposed is a 7-foot horseshoe section with a minimum capacity of 200 second-feet, 64 square feet of gate opening will be provided by two 4 by 8 foot cast-iron, bronze seated sluice gates, with a flashboard groove ahead of the gate in which stop planks can be placed in case of an emergency The outlet tunnel, located entirely in cut on the east end of the dam, will have a length of 250 feet discharging into a canal, with a base width of 16 feet.

Water will be conveyed for about 400 feet in this canal to the proposed heading for canals Nos. 3 and 4 for the upper irrigable area. At this point a concrete spillway structure will be constructed for spilling water for the lower canals into the river channel. Screw-lift slide gates will be provided for the canal heading, and a 6 by 16 foot radial gate will control diversion of water to the river channel.

The estimated unit costs are based upon the fact that a portion of the construction equipment required for the dam is now available for transfer at a reasonable cost from other projects in this district. The unit costs include all equipment charges and depreciation and all field overhead items, but does not include the general overhead expense of engineering, superintendence, accounts, and contingencies, which is provided for by a percentage addition to the total cost.

Since it will be more economical to handle excavation operations and material by power excavating machines, and that they will be

required on the job, it is believed that greater economy in sluicing operations will result if power excavators are used to handle and load flumes by drag line or shovel and water pumped only for transporting material and placing in dam. The material required for the dam is located above the dam elevation, and very little power will be required for moving other materials not sluiced in. It is proposed to move this material with 2½-ton dump cars, using a small gasoline locomotive to move empty cars to borrow pits.

ESTIMATED COSTS

Dam design No. 1

Top of dam, elevation ..... feet	4, 300
Storage ..... acre-feet	22, 000
Spillway crest, elevation ..... feet	4, 286
(1) Cut-off trench excavation, 34,900 cubic yards, at $0.20	$6, 980. 00
(2) Upstream blanket, 52,000 cubic yards, at $0.40	20, 800. 00
(3) Dam:	
Rock fill, 43,000 cubic yards, at $1	43, 000. 00
Clay fill, sprinkled and rolled, 132,000 cubic yards, at $0.50	66, 000. 00
Hydraulic fill, 89,300 cubic yards, at $0.40	35, 720. 00
Riprap, hand placed, 8,000 cubic yards, at $1.50	12, 000. 00
(4) Outlet works:	
Excavation, 13,500 cubic yards, at $0.20	2, 700. 00
Concrete, 320 cubic yards, at $25	8, 000. 00
Gates and hoists (installed)	4, 500. 00
Gate house, bridge, etc	1, 000. 00
Canal heading and spillway structure	3, 500. 00
(5) Spillway:	
Rock excavation, 4,000 cubic yards, at $2.50	10, 000. 00
Earth excavation, 30,000 cubic yards, at $0.20	6, 000. 00
Dry rubble and grouted riprap, labor placing rock from excavation, 2,000 cubic yards, at $1	2, 000. 00
Retaining walls, concrete, 208 cubic yards, at $25	5, 200. 00
(6) Embankment (west end of spillway), 8,000 cubic yards, at $0.50	4, 000. 00
(7) Stream control during construction	2, 000. 00
Dike provided by excavation upstream cut-off trench.	
(8) Right of way (Parker ranch)	8, 600. 00
	242, 000. 00
Engineering, superintendence, and contingencies, 20 per cent	48, 400. 00
Total estimated cost	290, 400. 00
Cost per acre-foot of storage	13. 20

Alternative design No. 1

Top of dam, elevation ..... feet	4, 305
Storage ..... acre-feet	30, 000
Spillway crest, elevation ..... feet	4, 291
(1) Cut-off trench excavation, 34,900 cubic yards, at $0.20	$6, 980. 00
(2) Upstream blanket, 52,000 cubic yards, at $0.40	20, 800. 00
(3) Dam:	
Rock fill, 43,000 cubic yards, at $1	43, 000. 00
Clay fill, 135,000 cubic yards, at $0.50	67, 500. 00
Hydraulic fill, 119,300 cubic yards, at $0.40	47, 720. 00
Riprap, hand placed, 9,000 cubic yards, at $1.50	13, 500. 00
Cut-off wall, concrete, 50 cubic yards at $25	1, 250. 00

(4) Outlet works:	
Excavation, 13,500 cubic yards, at $0.20	$2, 700. 00
Concrete, 320 cubic yards at $25	8, 000. 00
Gates and hoists (installed)	4, 500. 00
Gate house, bridge, etc	1, 000. 00
Canal heading and spillway structure	3, 500. 00
(5) Spillway:	
Rock excavation, 4,000 cubic yards, at $2.50	10, 000. 00
Earth excavation, 30,000 cubic yards, at $0.20	6, 000. 00
Dry rubble and grouted riprap, labor placing rock from excavation 2,000 cubic yards, at $1	2, 000. 00
Retaining walls, concrete, 208 cubic yards, at $25	5, 200. 00
(6) Embankment (west end of spillway), 10,000 cubic yards, at $0.50	5, 000. 00
(7) Stream control during construction	2, 000. 00
Dike provided by excavation upstream cut-off trench.	
(8) Right of way (Parker ranch)	8, 600. 00
	259, 250. 00
Engineering, superintendence, and contingencies, 20 per cent	51, 850. 00
Total estimated cost	311, 100. 00
Cost per acre-foot of storage	10. 37

Dam design No. 2

Top of dam, elevation ... feet	4, 300
Storage ... acre-feet	22, 000
Spillway crest, elevation ... feet	4, 286
(1) Estimate same dam, design No. 1	$242, 000. 00
Additional items:	
(2) Excavation of river bed sand under clay blanket, 75,000 cubic yards, at $0.20	15, 000. 00
(3) Pumping and unwatering river bed	5, 000. 00
(4) Additional fill, 10,000 cubic yards at $0.40	4, 000. 00
	266, 000. 00
Engineering, superintendence, and contingencies	53, 200. 00
Total estimated cost	319, 200. 00
Cost per acre-foot of storage	14. 50

Alternative design No. 2

Top of dam, elevation ... feet	4, 305
Storage ... acre-feet	30, 000
Spillway crest, elevation ... feet	4, 291
(1) Estimate same as alternative dam design No. 1	$257, 750. 00
Additional items:	
(2) Excavation of river bed sand under clay blanket, 75,000 cubic yards, at $0.20	15, 000. 00
(3) Pumping and unwatering river bed	5, 000. 00
(4) Additional fill, 10,000 cubic yards, at $0.40	4, 000. 00
	281, 750. 00
Engineering, superintendence, and contingencies	56, 350. 00
Total estimated cost	338, 100. 00
Cost per acre-foot of storage	11. 27

Dam design No. 3

Top of dam, elevation ... feet	4, 300
Storage capacity ... acre-feet	22, 000
Spillway Crest, elevation ... feet	4, 286
(1) Cut-off trench excavation, 34,900 cubic yards, at $0.20	$6, 980. 00
(2) Upstream blanket,[1] 26,000 cubic yards, at $0.40	10, 400. 00

(3) Dam:	
Rock fill, 45,000 cubic yards, at $1	$45, 000. 00
Coarse gravel and rock fill, 20,000 cubic yards, at $0.70	14, 000. 00
Hydraulic fill, 141,300 cubic yards, at $0.40	58, 520. 00
Clay fill, sprinkled and rolled, 46,000 cubic yards, at $0.50	23, 900. 00
Riprap, dumped rock, 9,000 cubic yards, at $1	9, 000. 00
Riprap, dumped gravel, 10,000 cubic yards, at $0.60	6, 000. 00
Cut-off wall, concrete, 80 cubic yards, at $25	2, 000. 00
(4) Outlet works:	
Excavation, 13,500 cubic yards, at $0.20	2, 700. 00
Concrete, 320 cubic yards, at $25	8, 000. 00
Gates and hoists (installed)	4, 500. 00
Gate house, bridge, etc	1, 000. 00
Canal heading and spillway structure	3, 500. 00
(5) Spillway:	
Rock excavation, 4,000 cubic yards, at $2.50	10, 000. 00
Earth excavation, 30,000 cubic yards, at $0.20	6, 000. 00
Dry rubble and grouted riprap, labor placing rock from excavation, 2,000 cubic yards, at $1	2, 000. 00
Retaining walls, concrete, 208 cubic yards, at $25	5, 200. 00
(6) Embankment (west end of spillway), 8,000 cubic yards, at $0.50	4, 000. 00
(7) Stream control during construction	5, 000. 00
Dike from excavation upstream cut-off trench.	
(8) Right of way (Parker ranch)	8, 600. 00
	235, 400. 00
Engineering, superintendence, and contingencies, 20 per cent	47, 080. 00
Total estimated cost	282, 480. 00
Cost per acre-foot of storage	$12. 84

Alternative design No. 3

Top of dam, elevation feet	4, 305
Storage capacity acre-feet	30, 000
Spillway crest, elevation feet	4, 291
(1) Cut-off trench excavation, 34,900 cubic yards, at $0.20	$6, 980. 00
(2) Upstream blanket,[1] 26,000 cubic yards, at $0.40	10, 400. 00
(3) Dam:	
Rock fill, 50,000 cubic yards, at $1	50, 000. 00
Coarse gravel fill, 20,000 cubic yards, at $0.70	14, 000. 00
Cut-off wall, concrete, 80 cubic yards, at $25	2, 000. 00
Clay fill, sprinkled and rolled, 51,000 cubic yards, at $0.50	25, 500. 00
Hydraulic fill, 167,800 cubic yards, at $0.40	67, 120. 00
Riprap, dumped rock, 10,000 cubic yards, at $1	10, 000. 00
Riprap, dumped gravel, 10,000 cubic yards, at $1.50	5, 000. 00
(4) Outlet works:	
Excavation, 13,500 cubic yards, at $0.20	2, 700. 00
Concrete, 320 cubic yards, at $25	8, 000. 00
Gates and hoists (installed)	4, 500. 00
Gate house, bridge, etc	1, 000. 00
Canal heading and spillway structure	3, 500. 00
(5) Spillway:	
Rock excavation, 4,000 cubic yards, at $2.50	10, 000. 00
Earth excavation, 30,000 cubic yards, at $0.20	6, 000. 00
Dry rubble and grouted riprap, labor placing rock from excavation, 2,000 cubic yards, at $1	2, 000. 00
Retaining walls, concrete, 208 cubic yards, at $25	5, 200. 00
(6) Embankment (west end of spillway), 10,000 cubic yards, at $0.50	5, 000. 00
(7) Stream control during construction	5, 000. 00
Dike from excavation upstream cut-off trench.	

[1] Sheet piling across river bed may be substituted for upstream blanket at approximately same cost.

(8) Right of way (Parker ranch)	$8, 600. 00
	252, 500. 00
Engineering, superintendence, and contingencies, 20 per cent	50, 500. 00
Total estimated cost	303, 000. 00
Total estimated cost per acre-foot of storage	10. 25

Dam design No. 4

Top of dam, elevation ... feet	4, 300
Storage ... acre-feet	22, 000
Spillway ... feet	4, 286
(1) Cut-off trench excavation, 34,100 cubic yards, at $0.20	$6, 820. 00
(2) Downstream rock fill, 47,500 cubic yards, at $1.50	71, 250. 00
(3) Dam:	
Rock fill, 39,000 cubic yards, at $1	39, 000. 00
Hydraulic fill, 224,300 cubic yards, at $0.40	89, 720. 00.
Riprap, hand placed, 8,000 cubic yards, at $1.50	12, 000. 00
(4) Outlet works:	
Excavation, 13,500 cubic yards, at $0.20	2, 700. 00
Concrete, 320 cubic yards, at $25	8, 000. 00
Gates and hoists (installed)	4, 500. 00
Gate house, bridge, etc	1, 000. 00
Canal heading and spillway structure	3, 500. 00
(5) Spillway:	
Rock excavation, 4,000 cubic yards, at $2.50	10, 000. 00
Earth excavation, 30,000 cubic yards, at $0.20	6, 000. 00
Dry rubble and grouted riprap, labor placing rock from excavation, 2,000 cubic yards, at $1	2, 000. 00
Retaining walls, concrete, 208 cubic yards, at $25	5, 200. 00
(6) Embankment (west end of spillway), 8,000 cubic yards, at $0.50	4, 000. 00
(7) Stream control during construction	3, 000. 00
(8) Right of way (Parker ranch)	8, 600. 00
	277, 290. 00
Engineering, superintendence, and contingencies, 20 per cent	55, 458. 00
Total estimated cost	332, 748. 00
Total estimated cost per acre-foot of storage	15. 12

Alternative dam design No. 4

Top of dam, elevation ... feet	4, 305
Storage capacity ... acre-feet	30, 000
Spillway crest ... feet	4, 291
(1) Cut-off trench excavation	$6, 820. 00
(2) Downstream rock fill, 47,500 cubic yards, at $1.50	71, 250. 00
(3) Dam:	
Rock fill, 45,000 cubic yards, at $1	45, 000. 00
Hydraulic fill, 251,300 cubic yards, at $0.40	100, 520. 00
Riprap, hand placed, 10,000 cubic yards, at $1.50	15, 000. 00
(4) Outlet works:	
Excavation, 13,500 cubic yards, at $0.20	2, 700. 00
Concrete, 320 cubic yards, at $25	8, 000. 00
Gates and hoists (installed)	4, 500. 00
Gate house, bridge, etc	1, 000. 00
Canal heading and spillway structure	3, 500. 00
(5) Spillway:	
Rock excavation, 4,000 cubic yards, at $2.50	10, 000. 00
Earth excavation, 30,000 cubic yards, at $0.20	6, 000. 00
Dry rubble and grouted riprap, labor placing rock from excavation, 2,000 cubic yards, at $1	2, 000. 00
Retaining walls, concrete, 208 cubic yards, at $25	5, 200. 00

(6) Embankment (west end of spillway), 8,000 cubic yards, at $0.50	$4, 000. 00
(7) Stream control during construction	3, 000. 00
(8) Right of way (Parker ranch)	8, 600. 00
	297, 090. 00
Engineering, superintendence, and contingencies, 20 per cent	59, 418. 00
Total estimated cost	356, 508. 00
Cost per acre-foot of storage	11. 88

Dam design No. 5

(No design shown on drawings)

This estimate is based upon a dam without rock fill; with a rolled and sprinkled clay core, and the remainder of embankment of hydraulic or mechanically placed fill. Upstream blanket for 200 feet above toe, or sheet piling substituted across river section; costs of blanket or sheet piling approximately the same.

FOR 22,000 ACRE-FEET STORAGE

(1) Cut-off trench excavation, 34,900 cubic yards, at $0.20	$6, 980. 00
(2) Upstream blanket, 32,000 cubic yards, at $0.40	12, 800. 00
(3) Dam:	
Rock and coarse gravel fill, 25,000 cubic yards, at $0.70	17, 500. 00
Clay fill, sprinkled and rolled, 125,000 cubic yards, at $0.50	62, 500. 00
Hydraulic fill, 138,000 cubic yards, at $0.40	55, 200. 00
Riprap, 9,000 cubic yards, at $1.50	13, 500. 00
Cut-off wall, concrete, 100 cubic yards, at $25	2, 500. 00
(4) Outlet works:	
Excavation, 13,500 cubic yards, at $0.20	2, 700. 00
Concrete, 320 cubic yards, at $25	8, 000. 00
Gates and hoists (installed)	4, 500. 00
Gate house, bridge, etc	1, 000. 00
Canal heading and spillway structure	3, 500. 00
(5) Spillway:	
Rock excavation, 4,000 cubic yards, at $2.50	10, 000. 00
Earth excavation, 40,000 cubic yards, at $0.20	8, 000. 00
Dry rubble and grouted riprap, labor placing rock from excavation, 2,000 cubic yards, at $1	2, 000. 00
Retaining walls, concrete, 208 cubic yards, at $25	5, 200. 00
(6) Embankment (west end of spillway)	4, 000. 00
(7) Stream control during construction	5, 000. 00
(8) Right of way (Parker ranch)	8, 600. 00
	233, 480. 00
Engineering, superintendence, and contingencies, 20 per cent	46, 696. 00
Total estimated cost	280, 176. 00
Total estimated cost per acre-foot of storage	12. 72

FOR 30,000 ACRE-FEET STORAGE

(1) Cut-off trench excavation, 34,900 cubic yards, at $0.20	6, 980. 00
(2) Upstream blanket, 32,000 cubic yards, at $0.40	12, 800. 00
(3) Dam:	
Rock and gravel fill toes, 30,000 cubic yards, at $0.70	21, 000. 00
Clay fill, 132,000 cubic yards, at $0.50	66, 000. 00
Hydraulic fill, 164,300 cubic yards, at $0.40	65, 720. 00
Riprap, 10,000 cubic yards, at $1.50	15, 000. 00
Cut-off wall, concrete, 100 cubic yards, at $25	2, 500. 00
(4) Outlet works:	
Excavation, 13,500 cubic yards, at $0.20	2, 700. 00
Concrete, 320 cubic yards, at $25	8, 000. 00
Gates and hoists (installed)	4, 500. 00
Gate house, bridge, etc	1, 000. 00
Canal heading and spillway structure	3, 500. 00

(5) Spillway:	
Rock excavation, 4,000 cubic yards, at $2.50	$10, 000. 00
Earth excavation, 40,000 cubic yards, at $0.20	8, 000. 00
Dry rubble and grouted riprap, labor placing rock from excavation, 2,000 cubic yards, at $1	2, 000. 00
Retaining walls, concrete, 208 cubic yards, at $25	5, 200. 00
(6) Embankment (west end of spillway)	5, 000. 00
(7) River control during construction	5, 000. 00
(8) Right of way (Parker ranch)	8, 600. 00
	253, 500. 00
Engineering, superintendence, and contingencies, 20 per cent	50, 700. 00
Total estimated cost	304, 200. 00
Total estimated cost per acre-foot of storage	10. 13

Summary of estimated costs

Dam design	Storage capacity	Estimated cost	Cost per acre-foot
	Acre-feet		
No. 1	22, 000	$290, 400. 00	$13. 20
No. 1 (alternate)	30, 000	311, 100. 00	10. 37
No. 2	22, 000	319, 200. 00	14. 51
No. 2 (alternte)	30, 000	338, 100. 00	11. 27
No. 3	22, 000	282, 480. 00	12. 84
No. 3 (alternate)	30, 000	303, 000. 00	10. 10
No. 4	22, 000	332, 748. 00	15. 12
No. 4 (alternate)	30, 000	356, 508. 00	11. 88
No. 5	22, 000	280, 176. 00	12. 72
No. 5 (alternate)	30, 000	303, 200. 00	10. 13

Recommended expenditure for reservoir	$300, 000. 00
Estimated cost to complete canal and lateral system for lower area	50, 000. 00
Estimated cost to construct canal and lateral system for upper allotted area	60, 000. 00
Construction expenditure to date	130, 840. 00
Total, estimated cost of completed project	540, 840. 00
Total cost per acre (10,280 acres) of completed project	52. 61

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APPENDIX A

Water record, Walker River project, Schurz, Nev.

1924

Date	Second-feet	Date	Second-feet	Date	Second-feet	Date	Second-feet
Apr. 8	15	Apr. 26	11	May 14	56	June 1	15
Apr. 9	15	Apr. 27	11	May 15	39	June 2	16
Apr. 10	16	Apr. 28	12	May 16	39	June 3	11
Apr. 11	11	Apr. 29	7	May 17	51	June 4	7
Apr. 12	7	Apr. 30	6	May 18	51	June 5	0
Apr. 13	7	May 1	9	May 19	50	June 6	10
Apr. 14	7	May 2	13	May 20	24	June 7	10
Apr. 15	7	May 3	13	May 21	27	June 8	1
Apr. 16	36	May 4	37	May 22	28	June 9	1
Apr. 17	22	May 5	44	May 23	28	June 10	1
Apr. 18	55	May 6	55	May 24	24	June 11	1
Apr. 19	39	May 7	48	May 25	22	June 12	11
Apr. 20	35	May 8	40	May 26	18	June 13	21
Apr. 21	28	May 9	26	May 27	25	June 14	23
Apr. 22	28	May 10	24	May 28	30	June 15	1
Apr. 23	12	May 11	28	May 29	39		
Apr. 24	12	May 12	54	May 30	40		
Apr. 25	12	May 13	72	May 31	16		

NOTE.—The above amounts represent the actual water diverted at the diversion dam. No water after June 15. The first water to reach the diversion dam after this date was on Jan. 1, 1925.

1925

Mar. 15	3	Apr. 27	6	June 9	50	July 22	90
Mar. 16	3	Apr. 30	6	June 10	50	July 23	90
Mar. 17	3	May 1	5	June 11	50	July 25	35
Mar. 18	3	May 5	5	June 12	32	July 26	35
Mar. 19	3	May 6	30	June 14	32	July 27	35
Mar. 20	3	May 7	30	June 15	26	July 28	15
Mar. 21	3	May 8	50	June 16	25	July 29	16
Mar. 22	3	May 10	15	June 17	18	July 30	16
Mar. 23	16	May 11	41	June 18	9	July 31	15
Mar. 24	18	May 12	37	June 19	7	Aug. 1	16
Mar. 25	18	May 13	36	June 20	7	Aug. 3	28
Mar. 26	30	May 14	35	June 21	4	Aug. 5	43
Mar. 27	50	May 15	74	June 22	4	Aug. 8	35
Mar. 28	81	May 16	80	June 23	0	Aug. 9	33
Mar. 29	91	May 17	75	June 26	0	Aug. 10	45
Mar. 30	102	May 18	70	June 27	15	Aug. 15	45
Mar. 31	65	May 19	29	June 28	24	Aug. 20	45
Apr. 1	40	May 20	25	June 29	25	Aug. 24	45
Apr. 2	38	May 21	21	June 30	54	Aug. 25	10
Apr. 3	19	May 22	25	July 1	76	Aug. 28	10
Apr. 4	33	May 23	12	July 5	76	Aug. 29	38
Apr. 6	50	May 24	10	July 6	70	Aug. 31	38
Apr. 7	27	May 25	38	July 7	85	Sept. 1	25
Apr. 9	20	May 26	40	July 8	72	Sept. 3	25
Apr. 11	16	May 27	38	July 10	60	Sept. 4	45
Apr. 13	12	May 28	16	July 12	6	Sept. 7	45
Apr. 15	12	May 30	12	July 14	6	Sept. 10	45
Apr. 16	31	May 31	8	July 15	12	Sept. 13	45
Apr. 17	13	June 1	8	July 16	13	Sept. 15	20
Apr. 19	10	June 4	8	July 17	15	Sept. 25	20
Apr. 21	12	June 5	12	July 18	34	Sept. 30	20
Apr. 23	22	June 6	12	July 19	32		
Apr. 24	29	June 7	12	July 20	28		
Apr. 26	11	June 8	32	July 21	80		

NOTE.—Only stock water was diverted after Sept. 30, which amounted to 18 to 20 second-feet per day.

Water record, Walker River project, Schurz, Nev.—Continued

1926

Date	Second-feet	Date	Second-feet	Date	Second-feet	Date	Second-feet
Mar. 15	21	Apr. 18	34	May 22	88	June 25	35
Mar. 16	2	Apr. 19	32	May 23	84	June 26	27
Mar. 17	19	Apr. 20	35	May 24	68	June 27	10
Mar. 18	21	Apr. 21	35	May 25	64	June 28	10
Mar. 19	21	Apr. 22	38	May 26	54	June 29	27
Mar. 20	20	Apr. 23	36	May 27	57	June 30	19
Mar. 21	20	Apr. 24	34	May 28	47	July 1	27
Mar. 22	19	Apr. 25	38	May 29	42	July 2	40
Mar. 23	18	Apr. 26	58	May 30	46	July 3	40
Mar. 24	18	Apr. 27	60	May 31	35	July 4	35
Mar. 25	17	Apr. 28	47	June 1	35	July 5	27
Mar. 26	15	Apr. 29	45	June 2	40	July 6	29
Mar. 27	14	Apr. 30	38	June 3	35	July 7	34
Mar. 28	13	May 1	33	June 4	43	July 8	42
Mar. 29	13	May 2	33	June 5	54	July 9	37
Mar. 30	14	May 3	37	June 6	45	July 10	40
Mar. 31	14	May 4	35	June 7	41	July 11	42
Apr. 1	20	May 5	40	June 8	47	July 12	37
Apr. 2	29	May 6	47	June 9	42	July 13	35
Apr. 3	35	May 7	42	June 10	42	July 14	37
Apr. 4	34	May 8	41	June 11	47	July 15	40
Apr. 5	45	May 9	47	June 12	58	July 16	33
Apr. 6	49	May 10	37	June 13	66	July 17	12
Apr. 7	52	May 11	47	June 14	106	July 18	0
Apr. 8	47	May 12	42	June 15	84	July 19	0
Apr. 9	52	May 13	52	June 16	57	July 20	0
Apr. 10	45	May 14	41	June 17	50	July 21	0
Apr. 11	35	May 15	50	June 18	40	July 22	6
Apr. 12	46	May 16	54	June 19	10	July 23	18
Apr. 13	46	May 17	50	June 20	10	July 24	20
Apr. 14	21	May 18	50	June 21	7	July 25	20
Apr. 15	19	May 19	84	June 22	2		
Apr. 16	17	May 20	108	June 23	7		
Apr. 17	17	May 21	118	June 24	11		

NOTES.—No water, river dry until Oct. 29.

APPENDIX B

Climatological data, Walker River project, Schurz, Nev.

[From U. S. Weather Bureau records, January, 1920–December, 1926]

NOTE.—Temperature in degrees Fahrenheit. Precipitation in inches

	Temperatures			Precipitation
	Maximum	Minimum	Mean	
1920				
January	64	1	34.5	0.00
February	61	10	33.0	.45
March	72	13	38.9	.38
April	79	29	47.5	.02
May	79	39	59.5	.00
June	80	31	62.0	.15
July	96	41	69.4	.06
August	100	41	69.5	.95
September	92	29	61.6	.00
October	85	19	47.4	.11
November	71	13	39.1	.38
December	59	9	34.8	.50
Total				3.00
1921				
January	66	1	33.6	.18
February	72	6	34.9	.01
March	75	20	51.2	.35
April	79	15	45.0	.03
May	85	27	55.0	1.63
June	96	33	66.0	.28
July	96	34	70.0	.02
August	95	42	68.5	.10
September	88	27	58.0	.12
October	84	12	51.0	.02
November	74	2	42.6	.09
December	67	6	35.0	1.23
Total				4.06
1922				
January	48	17	23.9	.78
February	59	4	35.0	1.19
March	70	1	39.0	.66
April	75	12	44.0	.35
May	86	23	56.0	.12
June	100	41	63.0	.55
July	101	40	70.0	.27
August	94	36	67.0	1.06
September	92	32	61.0	.00
October	81	28	51.0	.00
November	58	9	33.0	.20
December	60	9	34.0	.48
Total				5.66
1923				
January	66	11	34.0	.40
February	63	6	31.0	.12
March	72	11	40.0	.21
April	78	20	49.0	.64
May	87	28	58.0	.54
June	96	31	61.0	.84
July	101	42	74.0	.00
August	97	41	40.0	2.90
September	96	31	40.0	3.57
October	79	27	48.0	.34
November	68	15	42.0	.58
December	63	0	31.5	.24
Total				10.38
1924				
January	58	10	23.0	.32
February	70	12	41.0	.81
March	70	13	39.0	.55
April	79	19	52.0	.04
May	92	31	61.0	.00
June	102	33	66.0	.00
July	100	42	71.0	.90
August	105	37	70.0	.00
September	97	22	62.5	.01
October	84	21	53.0	.98
November	76	11	39.0	.32
December	40	24	32.0	.80
Total				4.73
1925				
January	66	11	34.0	.00
February	67	12	43.0	.30
March	88	11	44.7	.48
April	86	30	53.5	2.29
May	86	34	61.0	.46
June	105	36	65.0	.46
July	104	48	76.0	.83
August	95	39	68.0	1.30
September	91	26	63.0	.31
October	79	25	50.0	.84
November	66	13	38.0	.24
December	60	13	36.0	.25
Total				7.76
1926				
January	75	4	39.0	.42
February	70	18	30.0	.28
March	70	25	48.0	.21
April	90	28	56.0	1.04
May	90	28	61.0	0
June	100	52	76.0	0
July	100	45	75.0	0
August	102	36	70.5	0
September	95	23	58.5	0
October	86	15	55.5	.08
November	72	17	47.5	1.51
Total				3.54

APPENDIX C

DEPARTMENT OF THE INTERIOR,
UNITED STATES INDIAN IRRIGATION SERVICE,
Salt Lake City, Utah, May 11, 1920.

Mr. W. M. REED,
Chief Engineer Irrigation, Washington, D. C.

SIR: I am inclosing reports by Mr. Beemer on various schemes to secure additional water supply for the Walker River project.

I do not favor any cooperation with the irrigation district at this time. In the first place it is not yet a going concern, and, secondly, all their proposed storage is at or near the source of the river and any water released would have to run the gauntlet of every other water user on the river, and regardless of how binding and favorable an agreement one may enter into it does not get the water when needed.

I favor the reservoir on the reservation for various reasons as follows:

1. It is entirely within our own jurisdiction and under our own control.
2. The water is near our diversion and may be obtained at less expense and on shorter notice.
3. Being so close the reservoir may be used as an equalizing factor in the flow of the river, and much more efficient and less expensive operation of diversions may be maintained.
4. Being entirely independent we will be free from entangling alliances and future litigation.
5. Being at the lower end of the river we can take advantage of fluctuations in the river flow caused by break in upper canal systems or in mismanagement in control of other reservoirs. This will give a certain additional storage over the capacity of our reservoir.

The plans of dam, spillway, and control devices made by Mr. Beemer are merely studies and should not be considered too seriously; likewise his estimates are necessarily very approximate.

In general, the data submitted is intended to give you a general idea of the circumstances connected with possible storage.

The need for storage is great for the river drops far below present needs every summer when the water is most needed. The Indians would like to increase their acreage, yet development under present conditions should not be encouraged.

A great deal of money has been spent in constructing irrigation works, the fullest benefits of which can not be realized without additional water.

It is my plan to make borings at the reservation dam site as soon as funds the available, after which I will prepare plans and estimates with a view of asking for an appropriation for development.

Respectfully,

H. W. DIETZ, *Supervising Engineer.*

WALKER RIVER STORAGE STUDIES

DEPARTMENT OF THE INTERIOR,
UNITED STATES INDIAN SERVICE,
Schurz, Nev., March 25, 1920.

Mr. H. W. DIETZ,
Supervising Engineer, United States Indian Irrigation Service,
Salt Lake City, Utah.

DEAR SIR: In compliance with your letter of the 19th instant, I am submitting a compilation of data relative to our Walker River storage studies. The separate reports on this subject, which have been previously submitted, are considered a part of the present report and are referred to under the headings corresponding to their titles.

During 1918 and 1919 we have examined all the storage sites on the main Walker River and the East and West Forks and have looked into the scheme for developing a late water supply by draining Mason Valley lands.

In the list below are named eight different schemes that have been considered. These will be described in the order given.

POSSIBLE MEANS CONSIDERED FOR OBTAINING A SUPPLEMENTARY WATER SUPPLY FOR WALKER RIVER INDIAN RESERVATION

(1) Storage on the reservation.
(2) Alkali Lake storage.
(3) Leavitt Meadows storage.
(4) Bridgeport Meadows storage.
(5) Twin Lakes storage.
(6) Drainage of Mason Valley lands east of the river.
(7) Lowering river bed to drain Mason Valley lands.
(8) Awaiting development of the district and using run-off from irrigated lands above the reservation.

COOPERATION WITH THE DISTRICT

The first-named scheme, storage on the reservation, seems to be the only independent means by which the service can obtain a late season supply. Certain rights or options on all the upriver sites named have been acquitted by the district.

The Walker River irrigation district, with headquarters at Yerrington, Nev., is organized under the new Nevada irrigation act for the purpose of irrigating about 200,000 acres of land in Mason Valley and the valleys above. It is expected that the first bonds will be sold this coming May after which the development of the Alkali Lake project will be started. After this project is completed it is planned to complete the others as needed.

If the service does not choose the reservation site it should be able to cooperate with the district in developing one of the upper projects or by completing one entirely, and receive a certain stated flow in the river at the reservation line.

Arrangements should be made at the same time for the later development of the reservation site whenever the general need justifies it. This site should be developed some time because it will mean an annual saving of water to the valley as a whole in an amount equal to the capacity of the reservoir.

(1) STORAGE ON THE RESERVATION

The reservation site is located about 9 miles above Schurz. Reference is made to my report of December, 1918, containing detailed information and estimates of cost, and four drawings showing methods of construction upon which the estimates are based. Reference is made also to the topography of the reservoir site taken in 1914 by Frank Weber.

Further information relative to the nature of the materials under the river and spillway sites should be obtained by test borings before final designs are made.

ADVANTAGES AND DISADVANTAGES OF RESERVATION SITE

The advantages of using this site over cooperation with the district are that the storage works would be located on the reservation near the land to be served, which would facilitate regulation and delivery; and that its development would result in the saving of water that would otherwise all waste into Walker Lake. The latter consideration alone justifies developing this site at considerably greater cost because the needs of the valley as a whole soon will be in excess of the total water supply.

The principal disadvantages are greater cost, greater evaporation losses, and possibly greater loss of reservoir capacity due to silt deposit.

The cost per acre-foot of storage capacity, though greater than estimated for the upper sites, would still be reasonable. The lack of a good spillway site is the principal disadvantage which will make these works comparatively costly.

SILT DEPOSITS

The silt problem was not discussed in the report of December, 1918, so I will give here what information I have on this subject.

From observations of river and canals during 1918 and 1919, I have been able to form some idea of the amount of silt carried down the river. The general appearance of the river bed does not indicate excessive silt deposit and in the two years I have noticed little change in the size of the deposit in the lake at the river mouth. Above the diversion dam, for several hundred feet, is a rela-

tively quiet portion of the river. Here the silt deposit has not been very noticeable in the two years.

The two canals take out at bends in the river with no provision for keeping out silt, but it has not been necessary to clean either canal in the first two miles during the two years. The materials cleaned out below these upper stretches have been partly eroded from the canal banks and partly brought from the river. The amount taken out each year has been about 1,500 cubic yards. The quantity of water carried through the canals has been something like 4,000 acre-feet per year. Assuming that all this silt came from the river and that the amount of silt deposited in the canals by the diverted water is proportional to the amount that would be deposited in the reservoir by the water in the river, also that the amount of silt carried to the fields in irrigating is proportional to that which would be carried over the spillway and through the outlet, we can form some idea of the amount that might be left in the reservoir.

The average run-off into Walker Lake for 1915–1917 was 254,000 acre-feet according to United States Geological Survey records. Then according to the above assumptions 58 acre-feet of silt would be deposited in the reservoir yearly. This would not be at all serious, for at this rate, it would take about 170 years for the silt to fill the reservoir.

UPRIVER SITES

Alkali Lake and Leavitt Meadows on the West Walker and Bridgeport Meadows and Twin Lakes on the East Walker, which have been chosen for development by the district, are the best storage sites on the system. Considerable information relative to these in the form of reports and estimates, maps, etc., is on file at the office of the district in Yerrington. In this report I will try to condense this information so as to give a general idea of the nature of these sites and the probable cost of their development.

The United States Geological Survey has made topographic maps of all the country drained by the Walker River system.

(2) ALKALI LAKE STORAGE

Alkali Lake, in Antelope Valley, is in a natural basin lying west of the West Walker River at the right elevation to permit its being filled by diverting water from the river through a feed canal and returning the water thus stored to the river as needed, through a tunnel and open cut. The natural capacity is now about 40,000 acre-feet but this will be increased to about 85,000 acre-feet by building a low embankment at the south rim. This is an excellent storage site. The estimated cost is $5.50 per acre foot of storage capacity.

The capacity of Alkali Lake can be made 10,000 or 15,000 acre-feet greater than the 85,000 contemplated at about the same unit cost. It may be possible for the service to make arrangements with the district and secure necessary storage in this way.

(3) LEAVITT MEADOWS SITE

The dam site for this reservoir is in the river canyon in sec. 27, T. 6 N., R. 22 E., Mount Diablo meridian, about three-quarters of a mile below the mouth of Leavitt Creek. The area to be submerged is practically all of Leavitt Meadows, of which about 400 acres is privately owned.

A dam 110 feet high, to be built by hydraulicking with water from Leavitt Creek, is contemplated. The materials to be sluiced from the slopes of the canyon above elevation of top of dam are glacial drift. Pressure for hydraulicking work will be obtained by gravity. The site has a natural spillway and return channel.

The capacity of this reservoir site is about 25,000 acre-feet and the estimated cost is about $9 per acre-foot of capacity.

(4) BRIDGEPORT MEADOWS SITE

This dam site is on the East Walker in sec. 27, T. 6 N., R. 25 E., about 1,000 feet above the old tollhouse foundations and about 6 miles below Bridgeport.

The dam site is good but the reservoir will cover some valuable pasture lands. The dam will be built of glacial drift from the high west slopes of the canyon and can be deposited by hydraulicking. On the east side of the canyon is a good

spillway site in bedrock. The foundations seem to be good bedrock close to the river bed.

I have made two hurried estiamtes of cost, one for raising the water surface at the dam by 60 feet and one 70 feet, giving about 34,000 and 63,000 acre-feet of capacity, respectively. The estimated cost of construction is low, about $5 and $3 per acre-foot of capacity, respectively. But the areas covered by the reservoir are about 2,200 and 3,600. All but something like 1,000 acres lying nearest the dam site would have to be purchased. At $75 per acre to cover the purchase of these lands, the total of the estimate would be about $8 per acre-foot of capacity for each scheme.

It might be possible for the district and the service to work together to advantage in the development of this site.

(5) TWIN LAKES SITE

The other East Walker site is on its Robinson Creek branch at Twin Lakes, in Tps. 3 and 4 N., R. 24 E. Most of the reservoir area is now covered by Twin Lakes which have a present water area of about 700 acres. The United States Geological Survey topography shows these lakes and surrounding country very accurately.

At present the water surface of each lake is regulated by outlet works which store about 6,000 acre-feet. The cost of these works was probably about $6,000.

A cheap method of increasing the storage capacity would be to make a cut between the lakes and one at the lower lake outlet, making each cut about 6 feet below the present outlets, and to build an embankment across the creek and along a ridge just below the lower lake.

The embankment can be built at low cost by sluicing. Water can be diverted from Summers Creek and brought to a point directly above the site, giving about 600 feet of head, simply by building an easy ditch about 1,000 feet long. The flow of Summers Creek on July 19, 1919, was about 7 second-feet. The highest part of the fill, crossing the creek and outlet works, could be made by direct sluicing down the mountain side and the materials for the embankment farther to the west could be carried over in a flume.

The spillway can be made over a bed of bowlders at little cost and the channel back to the creek would clear the embankment at a safe distance and soon become permanent in a bed of bowlders like the creek channel.

The materials are glacial and are excellent for embankment work. A concrete conduit and controlling gates of standard design would comprise the outlet works.

My estimate of cost for a storage capacity of 20,000 acre-feet, or 14,000 acre-feet of additional storage over the present development, is $40,000, or about $3 per acre-foot of additional storage capacity.

I do not know what allowance should be made for satisfying claims of present users, but it would seem that if their use of the 6,000 acre-feet of stored water is not interfered with, the right to build larger and permanent works should be acquired on reasonable terms.

Not much information is to be found on the flow of Robinson Creek. On July 20, 1919, the inflow was about 20 second-feet. The cachment area above the lakes, taken from United States Geological Survey topography, is 35 square miles. This small area, however, lies mostly in high altitudes containing lakes and glaciers and probably furnishes considerably more run-off than its size would indicate. This would be a very desirable development for the service to handle alone if the necessary rights can be secured and the flow of Robinson Creek is found to be sufficient.

TOTAL WATER SUPPLY AVAILABLE FOR STORAGE

There is abundance of water escaping into Walker Lake at the present, of course, which passes the reservation site. The average yearly run-off for 1915–1917 was 254,000 acre-feet. (United States Geological Survey records.) After all is stored in the upper sites that possibly can be, there will certainly be enough escaping down river during the year to supply the 10,000 acre-feet needed for the reservation storage. Even the waste and drainage from the district lands should be ample for this.

As to the amount available for storage on the Walker River system as a whole, the report of W. E. Settlemeyer, assistant State engineer, dated May, 1919, contains the best and latest information I have found.

Mr. Settlemeyer obtained the following results after working up all United States Geological Survey records and adjudicated rights to date:

	Acre-feet
Mean East Walker flow, above all Mason Valley diversions	179, 200
Mean West Walker flow, above all Smith and Mason Valleys diversions	198, 896
Total	378, 096
Adjudicated rights in Mason and Smith Valleys on East and West Walker River	90, 372
Balance flowing into main Walker River at Mason	287, 724
Adjudicated rights, main Walker in Mason and Walker River Valley	127, 145
Surplus, mean quantity available for storage	160, 579

Neglecting back flow in Antelope and Smith Valleys.

The back flow from Antelope and Smith Valleys has been estimated between 20,000 and 30,000 acre-feet per year.

(6) DRAINAGE OF MASON VALLEY LANDS EAST OF RIVER

The report of Settlemeyer and Beemer, dated May 20, 1919, entitled "Mason Valley drainage studies," roughly covers this subject. A map of Mason Valley, made from United States Reclamation Service and United States Geological Survey data, dated May 20, 1919, forms a part of the report. There was also submitted a profile of Walker River, bearing the same date.

It will be noted in the report above mentioned that about 24,000 acres can be drained and thus greatly benefited by an east side trunk drain ditch. The water supply that would be developed in this way might be sufficient for the reservation.

In Engineering News-Record, April 3, 1919, D. W. Cole states that in 1916 the principal trunk drains on the Boise project discharged 224,000 acre-feet of water from a total area of 243,000 acres of irrigated land. A drainage run-off at this rate would give over 22,000 acres-feet from the 24,000 acres. In addition to this, about 8,000 acres below Yerrington drain directly into the river. If the plan of the district of removing all obstructions from the river below Yerrington is carried out and if the 24,000 acres are drained it seems that an adequate water supply for the reservation might be obtained in this way.

If the proper cooperation between the service and the district can be effected this is probably the best project under consideration.

(7) LOWERING RIVER BED TO DRAIN MASON VALLEY LANDS

This scheme was suggested by Mr. Jay H. Clemmons and a short report of it is contained in my letter of April 11,1919, accompanied by a profile of Walker River taken March 26 and 27, 1919, and by a map dated April 22, 1919, showing locations of diversions to be abandoned. This report is superseded by the report of May 20, 1919, referred to above under scheme (6). The late examinations brought out the fact that lowering the river would drain only a small part of Mason Valley below Yerrington on account of the peculiar topography as explained in the later report. The scheme of dredging the river should therefore be abandoned, but the diversions below Yerrington should be discontinued and the obstructions removed if scheme (6) is carried out.

(8) AWAITING STORAGE DEVELOPMENT BY THE DISTRICT AND DEPENDING UPON RUN-OFF FROM IRRIGATED LANDS ABOVE THE RESERVATION

This scheme is mentioned here because it has been suggested and not because of its merits. Referring to the report on scheme (6) and the accompanying map it will be seen that only a very small area below Yerrington drains into the river. Most of the drainage goes to Wabuska Basin and Birmingham Slough district and is lost through evaporation. Above Yerrington all available water during the late season will be diverted from the river. The late season supply reaching the reservation would therefore be very small.

RECOMMENDATIONS

The reservation site should be developed some time unless it is proven to be unsafe for construction. Whatever arrangement is made to secure a present water supply should include provisions for the future devlopment of this site, in

order to increase the storage supply for the valley as a whole, whenever increased demand justifies the construction.

Before the matter of cooperation is taken up with the district it is hard to say which of the above schemes is to be recommended. The choice would be one of three, viz:

(1) Drainage of Mason Valley lands.
(2) Development of Twin Lakes site.
(3) Cooperation in developing the Alkali Lake site.

If one of these is taken over by the service, a stipulated minimum late season flow to be delivered at the reservation line, should be agreed upon.

It might be well for the service to approach the district with an offer to do the engineering work for carrying out the drainage work (scheme 6), the actual cost of construction to be borne by the lands benefited. In this case the district could not be expected to guarantee a stipulated minimum flow, but the service would surely receive a considerable water supply at small cost.

It is recommended that the matter of cooperation by the service and the district be at once taken up with the district. After this is done a choice between the reservation site and one of the upper projects can be made.

Respectfully submitted.

J. A. BEEMER,
Superintendent of Construction.

MASON VALLEY DRAINAGE STUDIES

SCHURZ, NEV., *May 20, 1919.*

In compliance with instructions from Mr. H. W. Dietz, supervising engineer, United States Indian irrigation service, and Mr. J. G. Scrugham, State engineer of Nevada, the following preliminary report has been prepared, relative to drainage possibilities in Mason Valley, with the object of securing a late water supply for Walker River Reservation and at the same time benefiting Mason Valley lands.

It was first thought that the problem was a simple one. Walker River flows through nearly the center of the valley and appeared to be the finest drainage outlet. This, however, proved an illusion, for after a field examination it was found that the river is really higher than the natural drain courses near the hills on either side of the valley. The Wabuska Basin, into which the area west of the river and below Yerington is drained, is lower than river bed, and must be drained through Churchill Canyon into Carson River. A small area in the southern end of the valley and also land immediately adjacent to the river drain directly into it. And, most of area on the east side of the valley drains naturally into what is known as the Birmingham or Perk Slough, which lies from 2 to 4 miles east of and drains into Walker River before it leaves Mason Valley. These drains and approximate areas are shown on map which is part of this report.

Mason Valley has at least three district drainage areas, as follows: (1) The Wabuska Basin and lands on west side of the valley draining into it; (2) lands immediately adjacent to the river channel; (3) the area on the east side of valley.

The main drainage canal for the west side lands would join one from Wabuska Basin a short distance west of Wabuska, then flow through Churchill Canyon into Carson River. As the main purpose of this investigation has been to determine a means of obtaining more water for Walker River Indian Reservation and at same time to benefit Mason Valley lands, we need not now consider this part of the problem any further.

In considering the drainage of lands immediately adjacent to the river channel attention is invited to profile and map of Walker River, which are part of this report. The profile, covering a distance of nearly 8 miles, clearly shows the effect of obstructions placed in the channel to divert water. The probable grade that would result from the removal of these obstructions is also shown on profile and, as nearly as we can learn from statements of old settlers, is about the condition that existed before any diversions were made. On account of the relatively small area that could be directly drained by the river and because it seems reasonable that simply the removal of obstructions would result in the current deepening its own channel, it is not thought advisable to undertake any river improvement other than clearing out the obstructions. A plan is now being considered by the district to construct two rim canals and discontinue old diversions. This plan, if carried out, should result in the gradual restoration of the channel to its former condition.

The construction of a main trunk drain on the east side of the valley in approximately the location shown on map with this report would be of greatest benefit to both reservation and district. This location in general follows the Perk of Birmingham Slough which has been partly filled in by farmers owning land near its upper or southern end, the lower 3 or 4 miles only being open. Even in this condition it discharges some water into the river all year. There is considerable water-logged and swampy land that would be drained by a canal in this location. Farmers whose lands are now water-logged state that they were not so before the slough was filled. The probable area that would be drained by this canal and the estimated cost of the work are given below, also approximate area that might be drained directly by river:

Approximate area to be drained directly by river, 8,000 acres.
Approximate area to be drained by east side drainage canal, 24,000 acres.
Approximate length of east side canal, 10 miles.
Section for upper 4 miles, 8-foot depth, 4-foot base, 2 : 1 slopes.
Section for lower 6 miles, 10-foot depth, 6-foot base, 2 : 1 slopes.
Approximate yardage, east side canal, 440,000.
Estimated cost, east side canal, $90,000.

This has been necessarily a very hurried investigation, and further study must be given before definite plans are made. However, it is certain that district and reservation would be mutually benefited by an agreement securing the discontinuance and removal of diversions below Yerington and by construction of the east side drainage canal.

It is therefore recommended that Government and district cooperate in making careful surveys and estimates as a basis for a satisfactory agreement.

W. H. SETTELMEYER.
J. A. BEEMER.

WALKER RIVER STORAGE

Water rights.—The following is as obtained from the State engineer's office in August, 1918:

Vested rights—second feet:	Priority date
4.7	1868
3.55	1872
6.15	1875
7.50	1883
1.03	1886

Permits: No. 182 for 0.32 second-foot. No. 1914 for 48 second-feet, dated December 24, 1910, for the irrigation of 4,800 acres; works to be completed October 1, 1920, 30 days after which proof of beneficial use to be made.

More flood-water rights will be needed. R. G. Withers, attorney for the Indian Service, Washoe Bank Building, Reno, advised care in making further application so that no present rights will be surrendered. Also that it seems probable that irrigable Indian lands already have water rights and do not depend upon State decrees.

Maximum flood discharges at Schurz

[Letter of A. B. Purton, District Engineer, United States Geological Survey July 3, 1918.]

	Second-feet
June 8 and 9, 1914	2,530
June 12, 1915	1,180
June 20, 1916	1,500
June 21, 1917	1,950
June 18, 1918	2,100

Storage capacity.—Computed from Weber's topography of reservoir site. (See capacity curve on the accompanying map.)

Required spillway capacity.—Assumed as 4,000 second-feet.

Outlet works.—An open cut in the location shown on the map might be made and a reinforced concrete conduit of about 400 second-feet capacity constructed. This would take the flow of the river from July till the following spring and serve for the temporary diversion as well as the permanent outlet.

Foundation under river.—The soundings in the river bed were taken in the early part of September when the river was practically dry. They were made with sharpened bars of reinforcing steel which were churned down mostly without driving. In some places they had to be driven part of the distance, owing to streaks of clay and gravel. Where the bars would bounce when hit with the hammer, or where they could not be driven farther and were not gripped and held, the foundation was called rock. Where they were gripped for a few inches at the ends the foundation was called gravel. Solid bottom of some sort was always found. It seems probable that all the foundation is rock, but that in some places pockets of gravel or seams were struck. The material above the foundation is mostly fine sand, 10 to 17 feet deep in the river channel and shallower at the banks where it merges into clay. The sand could probably be moved with a centrifugal pump. The outcropping rock is a fine conglomerate, or between conglomerate and sandstone. It contains coarse and fine grains, firmly cemented, and bears evidence of heat.

Building materials.—Rock for riprapping is scarce. A small amount has been located near the site and the earth for the embankment contains some which might be selected as the work proceeds. There is considerable gravel and just below and on each side of the spillway site, but it does not appear to be of very good quality near the surface. No deep pits were dug. The earth near the embankment site contains enough clay and gravel to make it very good for the purpose. Plenty of good gravel and sand have been located about 2 miles from the site.

General scheme for construction.—(1) Construct outlet works before midsummer low water. (2) Temporary diversion. (3) Complete work in river bed in August, September, and October. (4) Complete remainder of embankment before spring flood. (5) Spillway work could be carried on all the time and should be completed well before spring flood.

Estimate of cost

Outlet works:		
5,000 cubic yards excavation at 60 cents	$3, 000	
4,000 cubic yards back fill at 30 cents	1, 200	
400 cubic yards reinforced concrete at $20	8, 000	
Gates, gatehouse, etc	4, 000	
		$16, 200
Temporary diversion		2, 000
Foundation under river and core wall:		
10,000 cubic yards excavation river, sand at 20 cents	2, 000	
100 cubic yards excavation for core wall at $5	500	
200 cubic yards concrete in core wall at $18	3, 600	
Back filling foundation, 10,000 cubic yards at 50 cents	5, 000	
		11, 100
Spillway:		
(10,000 cubic yards excavation, gravel and earth will be used near; cost of excavation covered in estimates for embankment and concrete work.)		
1,500 cubic yards concrete at $18		27, 000
Main embankment (exclusive of portion below river bed):		
90,000 cubic yards at 35 cents	$31, 500	
4,000 square yards upstanding face riprap	8, 000	
		39, 500
Drain:		
500 cubic yards cut at 50 cents	250	
1,700 cubic yards embankment at 30 cents	510	
		760
Total		[1] 96, 560

[1] Say, $100,000.

APPENDIX D

DEPARTMENT OF THE INTERIOR,
UNITED STATES INDIAN INSPECTION SERVICE,
Stewart, Nev., July 7, 1906.

The SECRETARY OF THE INTERIOR,
Washington, D. C.

SIR: In compliance with your order of March 31, 1906, I have investigated conditions on the Walker River Reservation, Nev., and have the honor to submit the following report:

Two plans have been submitted to the Indian office by Supt. J. R. Meskimmons, for furnishing the lands of this reservation with a water supply. His first recommendation contemplated the construction of a central steam pumping plant and the installation of a series of pumping stations at various points on the reservation. Or as an alternative pumping proposition he suggested it would be possible to elevate the water of Walker Lake to a height of 52 feet and cover the irrigable area south of Schurz containing the greater portion of the newly allotted lands.

An analysis of the lake water, however, which Superintendent Meskimmons had made by the chemist of the State university disclosed the fact that it contained some 266 parts of total soluble solids in 100,000 parts and the verdict of the chemist was that the water was not suitable for irrigation purposes. This fact is sufficiently disappointing to discourage the idea of using the water of Walker Lake even were other features of the plan more favorable than those existing.

The plan of erecting a central steam-electric plant at some point on the railroad to supply power to electrically driven pumping stations for furnishing a supplemental supply of water would not in my opinion, be practicable owing to the large cost of fuel, and the further fact that the Indian lands to be irrigated are mediocre in quality, located in a region where land values—based upon crop returns—are not sufficiently high to warrant such an expensive irrigation supply. The figures submitted as to initial cost and subsequent expense of operation for a similar central steam plant in my last report on the Pima project, were so large that the plan could not be enthusiastically indorsed even for a territory where lands with water are several times more valuable than they would ever become on the Walker River Reservation. If cheap water power could be obtained the plan of furnishing supplemental waters by pumping would be worthy of consideration. Unfortunately such power sites as could be constructed at reasonable expense are located many miles above the reservation on the East and West Walker Rivers, and the expense of transmission lines would be large.

Furthermore, it would hardly be practicable to construct such a plant in view of the fact that the electric power would only be needed for a few months of every year for irrigation purposes during the period of low water.

It is altogether probable, however, that ere long power of this nature will be brought down through the Smith and Mason Valleys by private capital and if so, might be extended on to the reservation, provided any mines of importance are found after the reservation is thrown open. Should this be done it would likely be much cheaper to rent a certain amount of power for the few months it would be needed during the period of low water in the river. This suggestion is somewhat speculative, however, but for the present pumping water on the reservation could not be recommended.

RESERVOIR CONSTRUCTION

Upon arriving in Carson City I took steps at once to ascertain the status of the Alkali Lake reservoir site, the acquirement of which was advocated in Superintendent Meskimmons's last report of March 2 as a possible solution of the water problem. By examining the records in the State and United States land offices it was found that Mr. T. B. Rickey owned or controlled by far the greater portion of the lands embracing the site in Nevada, including the lands on which would be located the outlet canals and tunnel. A portion of the site is in California and he has large holdings embracing the site in that State, including lands through which the supply canals leading from the West Walker River to the reservoir must of necessity traverse.

These facts are known to the department since I subsequently learned that Mr. Rickey had filed maps with his application for a permit to construct this reservoir which showed the relative areas of private and public lands.

I then visited the United States attorney, Samuel Platt, and learned that he has lately received instructions from the Attorney General to confer with Super-

vising Engineer Taylor, of the reclamation survey, and to take such steps as were necessary to protect the rights of the Government, all vacant lands contained within the said site having been withdrawn from entry under the provisions of the reclamation act.

Wishing to learn at once the intentions of the Reclamation Service with reference to the site in question, I conferred with Mr. Taylor, who informed me that it was not the intention of the survey to surrender this site. He gave it as his opinion that the Walker River project would be carried through, notwithstanding that the present attitude of some of the large landholders in the Smith and Mason Valleys is antagonistic to the idea of surrendering all of their holdings in excess of the areas specified in the reclamation act. He further stated that if the settlers on the Walker refused to conform to the requirements of the department, the storage waters could be conveyed by canals into the Carson River and be applied on other lands in connection with the Truckee-Carson project in process of construction.

I obtained from him the inclosed blue print which outlines in red ink the boundaries within which arid public lands have been withdrawn from entry under the first form of withdrawal.

It will be noted that these boundary lines embrace the Walker River from the Indian reservation to the headwaters of its chief tributaries, the East and West Walker, and the possible reservoir sites are noted thereon. Mr. Taylor stated that there was sufficient storage capacity in the reservoir sites shown or existing to provide all irrigable lands contiguous to Walker River with water, including the allotted lands of the reservation.

As matters now stand, therefore, I do not see how the Indians can at any time in the near future obtain the benefits of storage by proceeding along independent lines. If, however, the Government constructs these reservoirs in the future under the reclamation act, arrangements should be effected whereby the Indians may obtain additional water for their allotments.

The inclosed letter (Exhibit 1), received from the United States district attorney, gives the status of affairs to date in connection with the Alkali Lake reservoir proposition, and he also refers to the pending suit with reference to the adjudication of water rights on the Walker River in which the Government will intervene in behalf of the Indians.

In connection with the contemplated law suit referred to, I find that matters are somewhat in status quo at present.

The plan which it is hoped may be carried out in determining the rights of the various parties to the suit contemplates that the State engineer shall be appointed a master in chancery to take the testimony and compile the evidence offered by the respective appropriators of water from the river. Upon the evidence thus submitted he will consequently determine upon the relative priorities, basing his decision upon certain well-defined principles of irrigation law, which principles are to be subscribed to and agreed upon in advance by all parties to the suit. His findings to be the basis for a subsequent court decree.

The State engineer has been unable to date to bring about a unanimity of favorable opinion among the many parties to the suit with reference to the fundamental principles referred to. He is hopeful of success, but the outlook is not encouraging for a speedy adjudication along these lines.

It is an unfortunate fact that the Indians of the Walker River Reservation will not be able to obtain any considerable amount of water during seasons of scant supply subsequent to July 1.

The white settlers above them have been occupying and farming lands in the Smith and Mason Valleys for over 40 years, taking out ditches in the early sixties and having earlier priorities of appropriation than the Indians whose first attempt at ditch construction was begun in about 1868 by the building of what, as stated by Superintendent Meskimmons in his report of January 24, was but a small ditch and irrigated only a few acres of land which was irrigated not so much for cultivation as it was for raising wild hay. While they enjoy an early priority of diversion, the area of land irrigated was small.

If they can establish title to sufficient water during such periods to irrigate one-third of their present farmed areas of some 1,400 acres, it will be as much as we can reasonably count upon. Attorney Platt, with the data that have been furnished him by Special Agent Conser and Superintendent Meskimmons, will undoubtedly secure to the Indians their rights in the premises; but as matters stand, it is altogether probable that the larger portion of Indian holdings now in cultivation will be forced to depend chiefly on surplus spring and early summer's water for an irrigation supply.

After my conferences with United States Attorney Platt and Supervising Engineer Taylor relative to the Alkali Lake reservoir site, I proceeded to the Walker River Reservation, and in company with Superintendent Meskimmons made a journey up the Walker and West Walker Rivers, examining the dam site at lower end of Smith Valley en route. This is a fine natural site of bed rock, is within reasonable distance, but the storage capacity would not be large owing to the narrowness of the valley and heavy fall of river above the site. A masonry dam at this point carried to a height of 150 feet above the bed of stream would easily cost a million dollars; hence it is not a project for the Indian Bureau to consider. We then visited the Alkali Lake (Rickey) site, so soon to be a bone of contention. It is a fine natural site, an almost mountain-locked basin located a few miles from the West Walker River and into which the flood waters of the latter could be easily led by cheaply constructed canals. The water thus stored could be released from the reservoir by means of a tunnel and deep cuts through a low point in the rim of the basin.

The outlet works and the heavy dike, which would be about three-fourths of a mile in length at the upper end of site, would constitute the most expensive features of the work. Views 2, 3, and 4, pages A and B, attached, illustrate the nature of the site, and it will be noted that the bottom of the site, which contains about 280 acres of vacant Government land, is submerged, Mr. Rickey having been turning flood water into the basin for some time. At the time of our visit he had a small force of men engaged in the sinking of a large circular shaft for the construction of the gate tower on the line of the proposed outlet tunnel.

I subsequently met Mr. Rickey in Carson City upon his request and he gave me his views with reference to the proposed lawsuit concerning the division of the waters of Walker River. He also touched upon the reservoir proposition, and as I was about to leave asked if I thought the Indian Bureau would consider a proposition from him to furnish a supply of storage water to the Indian allotments on the reservation upon the completion of his reservoir. In view of my knowledge of the impending action against him by the Government, I could manifestly not give him any information with respect to the probable attitude of the Indian Bureau.

RECOMMENDATIONS

In view of the existing conditions and after a careful inspection of the lands of the reservation coupled with data obtained through preliminary surveys made by Superintendent Meskimmons under my direction, I have the honor to submit the following recommendations:

1. That the present reservation canal on the east side of Walker River known as ditch No. 2, be enlarged and extended to cover about 5,000 acres of allotments as indicated on accompanying map "A."
2. That Superintendent Meskimmons be directed to forward me the results of his final surveys now being conducted in accordance with my recommendations.
3. That Superintendent Asbury be instructed to at once make application with the State engineer for permission to appropriate 150 cubic feet of water per second of the surplus waters of Walker River for the benefit of the Indians for the contemplated enlarged canal, Superintendent Meskimmons to furnish him with the necessary details with reference to the proposed enlargement which will be demanded by the State engineer.
4. That the sum of $15,000 be apportioned the Walker River Reservation for irrigation work during the fiscal year 1907. A portion of this fund will need to be expended in the purchase of two plow teams, some slip and Fresno scrapers, plows, shovels, mattocks, doubletrees, etc., a full estimate of which will be submitted by Superintendent Asbury and Superintendent Meskimmons, should this recommendation be approved. If Superintendent Asbury be authorized to purchase this equipment, it will relieve the superintendent of irrigation from carrying same on his property account.
5. That the work be prosecuted under the personal supervision of Superintendent Meskimmons under the general direction of Engineer Hill or myself. The force of Indians which can be obtained will not be large, and the superintendent should be able to handle the work with a good foreman, one rodman, and a chainman. Later on he will need a few carpenters.

The reasons leading up to the recommendations above made are as follows:

An inspection of the Government records of the gauging station in Walker River near Wabuska located immediately above the reservation and below all

canals now diverting water from the Walker River or its tributaries, demonstrates the fact that except in unusually dry seasons there is ample water available until early in July to warrant this canal for the purpose of using the surplus or flood waters for grain crops.

I have interrogated many farmers and men familiar with the country and the concensus of opinion is, that if grain is planted early in March and irrigated copiously until July 1, a crop can be counted upon. I have personally examined many grain fields now growing which would yield excellent crops without further irrigation this season.

The records of flow at the station named for July 1 during the past five years are as follows:

July 1, 1902: Gauge height not given, but 47 second-feet being in river on July 22—demonstration that a good flow existed until July 10 at least.

July 1, 1903: 664 second-feet and 251 second-feet on July 9.

July 1, 1904: 1,082 second-feet and an abundance until August 31.

July 1, 1905: 114 second-feet on July 6—57 second-feet, a very dry year.

July 1, 1906: Highest water in many years and an abundance assured for all season.

Since one year of heavy snowfall such as occurred during the past winter, generally insures two succeeding seasons of ample summer water, it is altogether probable that the summer of 1907 will also show a substantial flow at Wabuska during July.

It is my belief, therefore, that sufficient surplus waters can be annually obtained for the growing of grain crops, and that this canal is warranted as in the instance of the New Yakima Canal, upon the grounds that a "half loaf is better than no bread."

There are some 5,000 acres of land newly allotted which will be covered by the proposed canal, but probably not to exceed 4,000 acres will be worth irrigating for the present at least. Some of the lands allotted to old people and situated near Walker Lake are very poor, comprising salt grass flats and sand dunes of a character which no white man would care to lease. Superintendent Casson purposely gave these lands to old people who would be unable to farm them even if of high grade.

From the results of such preliminary surveys as have been made to date under my direction I estimate the cost of covering the 5,000 acres at approximately $50,000, including the necessary laterals. If this expenditure is spread over a period of three years it will be probably as fast as the work can be prosecuted with the limited number of able-bodied men available. With the building of this canal and necessary laterals and the construction of a high-line lateral from ditch No. 3 covering some few hundred acres of land west of Schurz, the Indians will have all the land covered it will be possible for them to farm.

It is a discouraging feature in connection with this recommendation that the best of the lands to be covered by this canal are mediocre hence no great expense for reclamation would be warranted, such as would obtain by the building of central steam plants, independent storage reservoirs, or hydroelectric power plants.

The Indians have been given the best and practically all of the irrigable lands, however, hence there seems to be no other course to pursue save to build the ditches recommended and let them make the best possible use of their holdings.

The construction of this canal would be an essential preliminary to any plan for their relief which can be suggested.

It would be needed, with the quota of surplus or flood waters it will furnish the allotments, in event that supplemental waters be supplied the lands in the future either through storage or by means of pumping plants operated by rented hydroelectric power.

In closing I desire to speak thus early in behalf of these Indians. If the Government acquires and constructs in the future the Alkali Lake Reservoir in addition to others in contemplation in connection with the Walker River or other projects, I sincerely hope it will be your pleasure to effect some arrangements whereby these Indians may obtain the benefits of storage, and be insured future independence.

Inclosed herewith are letters forwarded me bearing upon the subject in hand.

Very respectfully,

W. H. Code, *Chief Engineer.*

APPENDIX E

REPORT OF WATER COMMISSIONER ON WALKER RIVER RELATIVE TO CONVEYANCE OF WATER FOR WALKER RIVER INDIAN RESERVATION PURSUANT TO FEDERAL COURT STIPULATION

YERINGTON, NEV., *September 1, 1924.*

This report contains a description of the principal features of the work of storing and conveying waters as provided for in stipulation No. C-125 of the Federal Court of the District of Nevada, dated July 11, 1924 (copy of which stipulation is hereto attached), and a statement of the results of this work.

On July 13, 1924, Mr. E. W. Kronquist met the writer at Bridgeport Dam on East Walker River, and the following plans were agreed upon as the most beneficial and effective for carrying out the provisions of the stipulation.

That as soon as the necessary arrangements could be made with the various water users the natural flow of upper West Walker River should be stored in Topaz Lake and the natural flow of upper East Walker River should be stored in Bridgeport Reservoir for a period of five days.

That these waters should be released from storage in as large streams as possible immediately after the end of the storage period, except that the release would be timed in order that the two streams might join in the main river.

That all additional water below the reservoirs required to be turned down should be added to the streams from the reservoirs at the proper times in order to increase the flow as much as possible.

That the district and the reservation should cooperate in the work of measuring, turning down, storing, releasing, and preventing losses and wrongful diversion of these waters.

On July 16 the writer outlined plans in writing for the work of Walter Cox, I. T. Whistler, and A. H. Rhoads who were given charge of parts of the work in different locations. Copies of these "memoranda" are submitted herewith. As Mr. King was present and assisted Mr. Kronquist and the writer in determining the methods to be followed, no written memorandum was furnished him.

In accordance with the above outlined plans, E. W. King, assisted by Herbert Shirley, turned down the natural flow of the various streams forming upper East Walker River into Bridgeport Reservoir for a period of five days, beginning July 17. A considerable amount of measuring and river riding was involved in this work due to the drawing of storage water from Twin Lakes and East Lake by other parties at this time. Mr. King also made measurements on West Walker and assisted in delivering the stored water from Topaz Lake. His statement covering his duties is attached hereto. A statement from the diary of Mr. Shirley, as submitted by him, covering his part of this work is also submitted herewith.

At 12.30 p. m. of July 22 the gates at Bridgeport Dam were raised, releasing stream of about 700 second-feet and the gates left unchanged so that the stream was cut down to 350 second-feet and the gates left unchanged so that the stream gradually grew smaller as the reservoir was emptied. At noon of the 23d, about 24 hours after the gates were raised, practically all the stored water had run out of the reservoir.

The amount of water stored in Bridgeport Reservoir for the reservation amounted to 314 acre-feet. Besides this water there was stored at the same time 116 acre-feet of water from East Lake which was purchased by Messrs. Strosnider and Scierini from Mono Power Co. This East Lake water, less conveyance losses, was delivered to its owners in upper Mason Valley at the time the water for the reservation was run, and an equal percentage of conveyance loss, as far as the point of delivery of the East Lake Water, was charged to each stream as nearly as practicable.

The amount of the total stored in Bridgeport Reservoir was determined by means of the automatic recorder located at the gauging station just below Bridgeport Dam, which station is cooperatively maintained by the United States Geological Survey and the Walker River irrigation district, the stored water being measured just after its release. The trace taken from the recorder containing record of this measurement is on file in the engineering office of the district. The amount run from East Lake during the five-day storage period was determined by measurements and gauge readings taken on Green Creek at a station in the Point Ranch, Bridgeport Meadows. The water passing this station during this period represented East Lake storage and Green Creek

natural flow and was delivered into Bridgeport Reservoir. Records of this flow are on file in the district engineering office.

The writer supervised the release of this water from storage at Bridgeport Dam and its conveyance down East Walker River as far as the Elbow. Some difficulty was experienced in preventing overflow and loss at several diversions in bad condition, and some waste could not be prevented. However, the loss through this upper stretch of river channel was not excessive, being probably about 15 per cent.

Just below the Elbow the East Walker River enters a canyon about 10 miles in length in which there are no diversions, so that in this stretch no patrolling of the river was necessary. Below this canyon I. T. Whistler was in charge of the work, and he was assisted by Mr. Kronquist. After the stream reached the Salles Ranch an excessive loss was sustained below the Salles Ranch, as from there down to the junction of the East and West Walker Rivers the bed is very sandy which caused considerable loss by seepage. Some loss was also due to poor diversion works having high brush dams and leaky headgates.

A statement by Mr. Whistler copied from his diary of that period, showing what part of the work he performed, is submitted herewith.

Just prior to the storage of this water in Bridgeport Reservoir the natural flow of East Walker was very low, being only about 10 second-feet at Bridgeport Dam. The lower portions of the river channel were therefore nearly dry. By the time the storage stream released from Bridgeport Dam reached the main river just above Mason it had dwindled to about 2 second-feet. After about one day even this much inflow to the main river began to drop, and it was then decided by Mr. Kronquist and the writer that in order to prevent waste we might deliver the remainder to Messrs. Strosnider and Scierini further up the river, which was done. This offset the loss considerably which these users would have otherwise suffered without detriment to the Indians, as it was evident that the small stream remaining would not be of any help in advancing the main head, which had already passed below the junction of the east fork with the main river.

On July 17, E. W. Kronquist, A. H. Rhoads, and the writer began the work of turning down the flow of upper West Walker River into Topaz Lake Reservoir. Mr. Rhoads continued this work until he completed the storage of five days' flow, amounting to 232 acre-feet. The amount of the water thus diverted into Topaz Lake was determined by means of a gauging station located in the feed canal leading from river to reservoir. A rating curve for this station was made from measurements by Mr. Kronquist and Mr. King. Herewith is a statement submitted by Mr. Rhoads, taken from his diary, which covers the part of this work performed by him. Records of measurements and gauge readings at this canal station are on file in the engineer's office of the district.

The delivery of the portion of the water from Topaz Lake Reservoir which was allotted to the Indians under the stipulation was effected simply by closing the headgates of users along the river, as a stream of about 85 second-feet was already being run continuously from this reservoir. The headgates were closed successively down the river until the proper amount of water had passed, after which they were again opened and ordinary service was continued as before. The upper headgates were thus closed on the evening of July 22, a few hours after the gates at Bridgeport Dam on East Walker were opened.

On July 24, between 6 and 8 o'clock p. m., the writer, accompanied by Walter Cox, found by rough measurements about 20 second-feet flowing into the main river from East Walker and about 70 second-feet passing under the bridge near Yerington Depot. The flow in the river at this place was then at about its maximum for the period of the run. A statement of Mr. Cox is herewith submitted.

Messrs. Kronquist and Philipson, from the reservation, had been working during that day with Messrs. Cox and King of the district in getting the water through Mason Valley. Here again considerable difficulty was had due to old brush dams, leaky headgates, etc., and some water was lost from these causes. By far the greatest losses occurred, however, from excessive seepage into the dry and partly dry portions of the river channel. If it had been possible to secure perfect regulation of the diversions, the water would have advanced somewhat farther than it did, but it certainly would have reached the heads of the reservation ditches.

Nearly all of the natural flow of both East and West Walker Rivers, just before the supply for the Indians was turned down, was being used in California. All of the water stored and about 90 per cent of the total supply sent down for the Indians under the stipulation was obtained by cutting off the diversions of

the California users. None of the rights of the California users are adjudicated except those of the Antelope Valley Land & Cattle Co., which company has very early priorities under the decree. The other users, not being subject to regulation under the decree, were using all of the supply available at their various diversions.

Messrs. Kronquist and Trotter, of the reservation, worked hard with us to accomplish this water delivery. We wish to acknowledge their fair and reasonable attitude which made it possible for us to cooperate amicably throughout the work.

JOHN A. BEEMER, *Water Commissioner.*

In the District Court of the United States of America, in and for the district of Nevada. United States of America, plaintiff, *v.* Walker River Irrigation District, a corporation, John A. Beemer, et al., defendants. No. C-125. Stipulation

Whereas a supply of a sufficient amount of water for irrigation and reclamation of portions of the Walker River Indian Reservation present certain engineering problems in addition to legal questions involving water rights; and

Whereas the Walker River irrigation district has constructed one large reservoir upon the West Walker River and is now constructing another large reservoir upon the East Walker River, involving an ultimate expenditure therefor approximating $1,000,000; and

Whereas such stored waters have the effect of increasing the amount of seepage or drainage water at the lower end of said river immediately above said Walker River Indian Reservation and from which it is believed that said Walker River Indian Reservation will derive much benefit; and

Whereas the said Walker River irrigation district contemplates the construction of a drainage system in the lower regions of said river which it is believed will tend to increase the amount of water available at that portion of the river; and

Whereas surveys have been made for a reservoir for the particular use of said Walker River Indian Reservation which, if constructed, would, together with the water that may be developed by such drainage work, solve the needs of said Walker River Indian Reservation; and

Whereas it will require time and the securing of further engineering data to properly determine the best solution of the problems involved; and

Whereas the irrigating season of 1924 being one of unprecedented drought, a present necessity exists for finding some means of relieving the situation now existing upon the Walker River Indian Reservation by reason of its location at the lower end of the Walker River system: Now, therefore, for the purpose of relieving the present necessities of said Walker River Indian Reservation,

It is hereby stipulated and agreed by and between the above-named plaintiff and the defendants, parties to this stipulation, by their respective attorneys or solicitors, subject to the approval of the court:

That the further hearing upon the order to show cause issued in this proceeding and dated July 3, 1924, may be continued until July 21, 1924, at 10 o'clock a. m., and may upon said date last mentioned be further continued by the court for periods of 10 days without further stipulation of the parties hereto.

That the preliminary restraining order issued in this proceeding on the 3d day of July, 1924, or as it may be modified, may be continued in force until the 21st day of July, 1924, subject to the following conditions:

(*a*) That the Walker River irrigation district, and other parties to this stipulation, consent, that they do hereby consent, that the natural flow of the West Walker River and its tributaries, subject to certain conditions hereinafter set forth, may be stored in Topaz Lake Reservoir for a period of five days and the water so stored may thereafter be discharged from said reservoir with a head of 100 cubic feet per second, or as near that volume as is practical, which said water shall be permitted to flow in the natural channel of said river to the Walker River Indian Reservation for the use of said reservation.

(*b*) That during the time the natural flow of the West Walker River and its tributaries is being stored in the said Topaz Lake Reservoir, as aforesaid, the natural flow of the East Walker River shall be permitted to flow in the natural channel of said river for purposes of priming said river.

(*c*) That the natural flow of said East and West Walker Rivers so to be used for the purposes of storing and priming shall not interfere with the use of a sufficient portion thereof for stock purposes and for necessary irrigation of garden and

vegetable crops, and that the surplus over and above such use shall only be used for storage and priming purposes.

That the use of the natural flow of the waters of East Walker River and West Walker River as aforesaid is subject to the further condition that all of the owners or persons claiming an interest in the natural flow of said streams, not parties to this stipulation, and particularly those who are not parties to the suit of Pacific Livestock Co. *v.* T. B. Rickey et al., or who now represent interests not involved or determined in that suit and who reside or own or claim water rights in the State of California, consent to and cooperate in the matter of storage of the natural flow of the West Walker River in said Topaz Lake Reservoir and in the permitting of the natural flow of the East Walker River to continue in the channel of said river for priming purposes as aforesaid.

That the foregoing paragraph providing for the natural flow of water in the east fork and the storage in Topaz Lake shall not be effective or take effect unless all the water users upon the said systems consent thereto or are made parties thereto by court orders and subject to restraining orders of a court of competent jurisdiction.

(*d*) That in the event the parties to this stipulation faithfully endeavor to carry out the same in so far as they are concerned, it shall be deemed a full compliance upon their part with all the terms and conditions of said restraining order and the same shall as to them be terminated.

(*e*) That the natural flow of said East and West Walker Rivers, to be stored or used for priming purposes as hereinbefore provided, shall be so stored or used prior to September 1, 1924.

(*f*) That the time of storage, priming, and the discharge of said stored water from said reservoir shall be determined by John A. Beemer and E. W. Kronquist, as water master under decree No. 731, and engineer of the Walker River Indian Reservation, respectively; provided that if the said Beemer and said Kronquist determine that any water so stored can not be economically delivered to the said Walker River Indian Reservation in an amount sufficient for practical, beneficial purposes, then such water so stored shall not be required to flow to waste in said river channel.

Nothing in this instrument shall be deemed to be a waiver of any rights of the respective parties or the acknowledgment of any right or claim of any party.

It is further stipulated and agreed that the defendants in the above-entitled suit who accept this stipulation have to and including December 10, 1924, in which to answer, otherwise plead, or move in respect to plaintiff's complaint.

Dated this July 11, 1924.

GEORGE SPRINGMEYER,
United States Attorney, Solicitor for Plaintiff.

Hoyt, Norcross, Thatcher & Woodburn, attorneys for Walker River irrigation district et al.
Brown & Bedford, attorneys for Antelope Valley Land & Cattle Co.
Clark J. Guild, attorney for J. B. Gallagher.
Platt & Sanford, attorneys for Plymouth Land & Stock Co. et al.

MEMORANDUM FOR MR. WALTER COX

JULY 16, 1924.

The storage of water for the Indians in both Bridgeport Reservoir and Topaz Lake begins July 16. After five days it is planned to raise the gates and send it down. The delivery of decreed water on the west fork and main river should be continued according to present priorities until the storage water reaches each head gate successively down the river, when the head gates should be closed for a period of five days. The stipulation, however, provides that a sufficient amount of the decreed water according to present priorities may be used for necessary stock purposes and the irrigation of gardens and vegetable crops. This includes potatoes.

The plan in general is to stop the use of all natural flow for a period of five days, closing each head gate at such time as to keep the flow in the river going down to the Indians as large as possible. You will be notified in time to arrange your work as to when the reservoir water is to be started down the river.

Your time book should have a separate statement covering cost of the work in getting the Indians' water down as we may have need of making a cost statement for this part of the work.

JOHN A. BEEMER, *Chief Engineer.*

MEMORANDUM FOR MR. WHISTLER

JULY 16, 1924.

Plans for storing and taking water down the East Fork for the use on the Indian Reservation have been decided as follows:

Storage in Bridgeport Reservoir to begin July 16, and will continue for five days.

You will be notified when this storage is to be turned loose in time so that you can arrange your work below. The natural flow below the reservoir should be delivered from the side streams so that it will reach the river at just about the same time reservoir water passes so that the stream going down the river will be kept as large as possible.

Delivery of decreed water, and the Green Creek storage water should be continued as usual until such time that the supply in the river is too small to deliver it. As soon as the supply in the river drops too low to make deliveries, as at present, the head gates should be closed and left closed for a period of five days. This should be continued on down the river as the supply falls below that sufficient for making deliveries as at present. If there is still sufficient water in the river to furnish the necessary amount for the lower diversions, the delivery should be continued until the reservoir water reaches the head gates, and then the head gates should be closed for five days.

The plan in general is to send down all natural flow for a period of five days according to the stipulation, at such times that the flow coming down the river will be helped along as much as possible. Provision C of the stipulation states that the natural flow to be used for the Indian supply in such a way as not to interfere with the use of a sufficient portion for stock purposes and for necessary uses of garden and vegetable crops. Therefore any user entitled to water at this time under the decree should be allowed such part of his decreed right as is necessary for stock water, gardens, or vegetables, which includes potatoes.

After a head gate has been closed for five days the delivery should then be resumed according to the priority now enforced, whether the storage water has all passed or not, but of course no more water should be allowed than the user is entitled to at present.

Mr. Strosnider has requested his Green Creek storage held in Bridgeport Reservoir along with the Indian supply and then deliver it along with the Indian water. As soon as it is not possible to deliver his storage after the reservoir gates are closed on the 16th his gate should be closed the same as the others. Then as soon as the stored water reaches his diversion he should receive his portion of it, the loss being divided between his and the Indian stream. You will be given the figures showing how much he will have stored in the reservoir during the five days.

Your time book should have a separate statement covering cost of the work in getting the Indians' water down as we may have need of making a cost statement for this part of the work.

JOHN A. BEEMER, *Chief Engineer.*

MEMORANDUM FOR MR. RHOADS

JULY 16, 1924.

The storage of natural flow above the reservoir is to begin July 16. Please clean out the moss or anything else that affects the gauge in the feed canal and divert all the river into the reservoir. The gauge in the canal should be read every day and twice a day if you can find time to do so.

You should get around to the diversions in Antelope Valley and the side streams and see that all the natural flow is turned down, beginning the 16th, excepting only such water as is actually needed for the stock and for gardens and vegetables. After a period of five days the use of the water may be continued as before.

Mr. Kronquist said that he would go up and make several measurements of the water in the canal. Whether he does so or not you should be sure to get the gauge readings and the time of day the readings are taken. The object is, of course, to get as nearly an accurate estimate as possible of the water turned into the lake during the five days.

After the delivery of the water for the Indians the plans for the distribution work will be again about as was outlined in the early spring, except that you will not need to go down the river below Hoye Bridge for any work. It is planned

for you to take care of any regulation above Hoye Bridge and to look after the delivery of water from the reservoir, and if possible to keep the tunnel intake and outlet cleaned so as to keep a smooth flow of water out of the lake as the water lowers.

Please show on your time sheet a separate statement of cost of your work in helping to deliver water to the Indians, as it may be necessary to make up a statement of the cost of your work in this office.

JOHN A. BEEMER, *Chief Engineer.*

YERINGTON, NEV., *September 5, 1924.*

I, E. W. King, residing at Wellington, Lyon County, Nev., do swear or affirm, that I was, on April 11, 1924, duly appointed as a water commissioner for Lyon and Douglas Counties, State of Nevada, by Jas. G. Scrugham, governor of said State of Nevada, which appointment was made on the recommendation of the Walker River irrigation district and also of Robert A. Allen, State engineer of said State of Nevada.

That I have been employed by the said Walker River irrigation district during the irrigating season of 1924 as an assistant to John A. Beemer, chief engineer of said district, and my duties have been to assist in the measuring and the distribution of water for irrigating purposes and the keeping of proper records of same in all parts of said Walker River irrigating district. That I have been at the same time an assistant to, and under appointment by Mr. John A. Beemer, commissioner under decree No. 731, United States District Court of the District of Nevada.

That, subsequent to the signing of a certain stipulation (a copy of which is hereto attached) in case No. C-125 in the United States District Court in and for the District of Nevada, wherein the United States of America is plaintiff *v.* Walker River Irrigation District, a corporation, John A. Beemer et al., defendants; I met with John A. Beemer and E. W. Kronquist, who had been appointed by said court to carry out the terms and conditions of said stipulation.

That at said meeting various methods of carrying out the terms of said stipulation were thoroughly discussed.

It was decided that better results would obtain if the waters of the East Fork of Walker River and its tributaries were stored by the dam at Bridgeport for five days and then permitted to flow out rapidly rather than to be allowed to flow steadily down the channel for the same period of time.

It was also decided that E. W. Kronquist and E. W. King should make such measurements of the flow of water in the East and West Walker Rivers and their various tributaries as might be deemed necessary to determine the actual flow of water in such rivers and tributaries and the actual amount (as near as could be determined) that might be stored in Topaz Lake and at the dam at Bridgeport, and that any of the water commissioners or ditch riders of the Walker River Indian Reservation, any and all water or waters contemplated or attempted to be stored and delivered under the terms of said stipulation.

That it was decided to have A. H. Rhoads, a water commissioner in the employ of the district, look after the natural flow through Antelope Valley of the West Walker River and the storing of same in the Topaz Lake.

To have Herbert Shirley, another water commissioner in the employ of the district, look after the natural flow of the East Walker River and its tributaries during the storing of same for the five-day period, as provided in the stipulation and to have Ike Whistler, another water commissioner in the employ of the district, look after the flow of same while coming down the natural channel of the East Walker River.

That affiant and E. W. Kronquist made three measurements of the flow of water from the West Walker River to Topaz Lake and constructed a measurement curve from said measurements from which the amount of water stored in Topaz Lake was computed. That a gauge was set in the intake canal to said Topaz Lake and that readings were taken twice daily and reported by A. H. Rhoads, and that said gauge readings showed that at least 232.5 acre-feet of water was stored in Topaz Lake during the five-day flow as provided in said stipulation.

That the following is a record of the gauge readings turned in to the office of the district by A. H. Rhoads:

Date	Hour	Gauge	Second-feet	Acre-feet
July 18	4.30 p. m.	1.00	11.80	(1)
19	9.30 a. m.	1.12	16.38	
19	4.30 p. m.	1.19	19.50	35.88
20	10 a. m.	1.30	26.86	
20	5.30 p. m.	1.30	26.86	53.72
21	8 a. m.	1.31	27.00	
21	8 p. m.	1.31	27.00	54.00
22	7.30 a. m.	1.31	27.00	
22	6 p. m.	1.31	27.00	54.00
23	7.30 a. m.	1.19	19.50	
23	5 p. m.	1.10	15.40	34.90
	Total stored			232.50

[1] Not used.

That on June 16 I visited all of the tributaries of the East Walker River in Bridgeport and made measurements of the flow of water in same and on the morning of July 17, the natural flow of Dogtown, Green, Robinson, Swauger, and Buckeye Creeks was, except stock water, turned into their natural channels, either by closing the head gates of all diversions or removing a section of the diversion dam where the head gate could not be closed.

Gauges were set and measurements made in each of the above streams and from these measurements curves were constructed for the keeping of the record of water delivered to the Bridgeport Dam.

Measurements were also made of the flow in the East Walker River, at a point below the junction of all of the above tributaries and it was found that there was a very considerable loss of water between the measurements made at this point and the measurements made where said tributaries entered the Bridgeport Valley, due undoubtedly to the fact that the river channel was nearly dry at the time that the flow of the tributaries was turned into the main channel.

That at 8 o'clock p. m. on June 22 all diversions in Smith Valley were closed and an uninterrupted flow of 85 second-feet of water was run from the Topaz Reservoir, through Smith Valley and past the United States Geological Survey gauge at Hudson for a period of 36 hours.

That on June 22 affiant notified, by telephone, Mr. John A. Beemer, who was at the Bridgeport Dam, that the water stored at Topaz Lake, for the Walker River Indian Reservation, had been released the night before and Mr. Beemer replied that he would immediately release the water from the Bridgeport Dam that had been stored for the same purpose.

That on July 24 affiant followed the released flow of water from the two above-mentioned sources, through Mason Valley, and, owing to the fact that both river channels were nearly dry below the junction of the East and West Walker Rivers, the flow decreased very rapidly and none of the water reached the concrete weir, about 3 miles below Yerington until 10 minutes past 2 o'clock p. m. July 24, and after watching same flow through said wier for more than an hour, there was not to exceed 8 second-feet flowing through said weir.

E. W. KING,
Deputy Water Commissioner.

REPORT OF HERBERT V. SHIRLEY RE RUNNING WATER FOR WALKER RIVER INDIANS

BRIDGEPORT DAM, *August 31, 1924.*

The following, taken from my July diary, covers the work performed by me while assisting in delivery of water for Walker River Indian Reservation:

July 15. Went from Bridgeport Dam to county hospital field (Scanavina's) to measure natural flow of Dog Creek.

July 16. Went from Bridgeport to county hospital field and shut off water from Dog Creek. Went from Bridgeport to Dressler's ranch (2 miles below Bridgeport) and measured water in Robinson Creek with Mr. King.

July 17. Went from Bridgeport Dam to Bridgeport and measured water in Virginia Creek 100 feet below bridge.

July 19. Went from Bridgeport to Dog Creek and from Bridgeport to Robinson Creek at Dressler's to read gauges.

July 21. Went from Antelope Valley Land & Cattle Co.'s "Point Ranch" to Dog Creek and from Bridgeport to Robinson Creek to read gauges.

July 22. Went from Bridgeport Dam to junction of Robinson and Virginia Creeks and measured both streams. Went from dam to Frederick's and Jensen's ranches and closed down head gates.

July 23. Went from Bridgeport Dam to Ravinell Ranch and measured "Rough and Bodie" Creek.

July 24. Went from Bridgeport Dam to Frederick's and Jensen's ranches and adjusted head gates.

Total number of miles traveled was 168.

HERBERT V. SHIRLEY, *Hydrographer.*

FROM DIARY OF I. T. WHISTLER RE HANDLING WATER FOR INDIAN RESERVATION

July 19, 1924: Went from Yerington to Bridgeport Dam via East Fork to help carry out Federal court stipulation relative to reservation water. Time consumed eight hours, and traveled 75 miles.

July 21, 1924: Left Bridgeport Dam at 7 a. m. to cover water in various tributaries of East Fork and to turn same into river as per term of stipulation. I first visited Sweetwater Creek where same leaves mountains. Found about 2½ second-feet coming out of mountains, but on following it down to where it is taken into ditches noted that stream had dwindled to a little more than stock water, and as this was at a point several miles from river I gave up any idea of getting any water from this creek.

I then visited Bodie Creek at a point called Sunshine but found even less water there. Then went to Fallons Nine Mile Ranch at confluence of Rough and Bodie Creeks where I opened up three dams and released about 1½ second-feet. From there visited Morgan's ranch on Rough and Half Way Creeks, thereby opening up three more dams. Got about 2 second-feet more. In both cases notified owners that all waters in these creeks was to run undisturbed for a period of five days.

I then returned to Bridgeport Dam, after being out 13 hours and traveling 111 miles.

July 22, 1924: Came down East Fork ahead of reservation water. Tore out dam at Elbow Ranch and one at Boerlin Ranch. Time, 8 hours; miles traveled, 75.

July 23, 1924: Went up East Fork with Mr. Kronquist to meet reservation water. Found it at Salles Ranch. Tore out dams and closed off all headgates not previously attended to. Time, 6 hours; miles, 55.

I. T. WHISTLER,
Deputy Water Commissioner.

(November, 1926: Mr. Whistler now makes the statement that "the reason this attempt to deliver water to the reservation was unsuccessful was because the users along the river stole the water, that gates could not be locked, and as soon as river riders left, some of the farmers immediately opened their gates again.")

FROM DIARY OF A. H. RHOADS RE HANDLING INDIANS' WATER

July 17: Turned the river into the lake at 7.30 a. m. Mr. Beemer came up at noon and we went to Topaz and told them that we were ready for the Indians' water, so Mr. Dominic went up and turned down the water in the company ditches.

July 18: Everything seems to be all O. K. Mr. Kronquist came down from Bridgeport to-day and we measured the water in the intake canal at 4.30 p. m.; 11.80 second-feet.

July 19: Mr. Kronquist and I took a look over the ditches to-day and found a little too much water running in the Alkali, so we turned some out and posted head-gate intake at 9.30; 16.38.

July 20: Intake at 10, 26.86 second-feet. Intake at 5.30 p. m., 26.86 second-feet. Everything all O. K.

July 21: Intake at 8, 27 second-feet. Intake at 6 p. m., 27 second-feet. Everything all O. K.

July 22: Intake 7.30 a. m., 27 second-feet. Intake 6 p. m., 27 second-feet. This is the fifth day, so I told the people that they could take their water any time after 3 p. m. Raised the gates and turned the water out of lake for the Indians at 7.30 p. m.

A. H. RHOADS,
Deputy Water Commissioner.

REPORT OF WALTER COX RE HANDLING INDIAN WATER

SEPTEMBER 5, 1924.

July 22: All ditches in Wilson Canyon were turned off and Indian water allowed to pass. July 26 they were reopened. On the evening of July 22 Whitacre and I tore out the Kelly Alkali Dam, allowing about 25 second-feet to go through.

July 23: Worked up and down the river closing leaky head gates.

July 24: Assisted Kronquist wrecking dams at the McLeod, Nichol, Campbell, and Merritt diversions.

July 25: Accompanied Mr. Philipson, of Schurz, to Gold Hill diversion. We found about 30 second-feet passing this diversion.

July 26: Saturday, at 10.30 a. m., still 27 second-feet passing through weir. In the afternoon Mr. Kronquist advised me to take entire river flow for our farmers but I let flow pass until Sunday noon.

The average flow for the three days' run through the weir was as follows:

	Second-feet
July 24	15
July 25	31
July 26	25

giving total of 142 acre-feet passing through the weir.

WALTER COX,
Deputy Water Commissioner.

In Equity, C-125. In the District Court of the United States of America in and for the District of Nevada. United States of America, plaintiff, *v.* Walker River Irrigation District (a corporation), John A. Beemer, Antelope Valley Land & Cattle Co. (a corporation), Arthur Pitts, Willie Pitts, H. F. Powell, Mrs. Elizabeth Chichester, B. H. Chichester, James Powell, Mrs. Eliza McKay, Mrs. Sarah Carney, Virgil Connell, Hunnewill Land & Livestock Co. (a corporation), James McKay, Frank Simpson, Truckee River General Electric Co. (a corporation), H. W. Settlemeyer, A. Settlemeyer, F. Schacht, Thomas Berry, Joe Allard, Sam Fales, Henry Rube, Eddie Rube, Joe Sorerine, A. Dellamonica, Modesto Dellamonica, Frank Yparraguirre, Mrs. Minnie Pimental, Mono Land & Livestock Co. (a corporation), C. C. Loose, Mrs. Annie B. Philatro, Fred Fredericks, G. B. Day, Mrs. H. P. Day Estate, Plymouth Land & Livestock Co. (a corporation), Leland Day, C. M. Kirkwood, A. S. Bryant, Lorene Wedertz, A. W. Brandon, Mrs. M. V. Sinnamon, C. E. Day, Frank W. Chichester, David McKay, Mrs. Bertrand Salles, Mrs. Olive Stewart, Louise Scanivino Estate, Joseph Scanivino, R. C. Terry, Fred Dunn, Frank Yparraguirre, Henry Baker, R. S. Brooks, D. J. Butler, A. Jensen, Patrick J. Conway, Battista Cremetti, A. Charlebois, Louis Saroni, Modesto Dellamonica, Maria Dellamonica, Rosie Dellamonica, Katie Dellamonica, Ulisee Dellamonica, Compston & Hacquet, A. H. Barlow, Clara Masterson, Harriet Estes, Hunnewill Land & Livestock Fox Co. (a corporation), J. M. Feeney, Mrs. Amanda Fenili, John F. Fredericks, Ditch Co. (a corporation), C. W. Gallagher, J. E. Gallagher, J. B. Gallagher, T. F. Gallagher, J. C. Gallagher, Ed. Hornleben, A. Scossa, A. Sciarini, Wm. Schacht, C. W. Hyatt, Flora Nicholas, F. H. Knemeyer, H. H. Steck, F. Robinson, Carlo Scatina, Charles Altman, Pursel Estate, H. C. Guild, Kate Smith Gage, John B. Gallagher, W. F. Freeman, Joe Faber, Andy Johnson, Mary Gallagher, Perazzo Bros., P. J. Conway, Edward Frederick Wade, Esther Sara Wade, Katherin I. Gallagher, Peter Gallagher, Paul H. Gallagher, John Gallagher, Fred Lammon, J. G. Gibbons, A. W. Gander, M. J. Green, Ira Fallon, Greenwood Ditch Co. (a corporation), G. Scatina, W. A. Pursel, George Freidhoff, Frank J. Mathews, Joseph Mathews, W. H. Spragg Estate, J. E. Gallagher, H. C. Kenna, C. A. Barrett, George F. Batchelder, Frank Hanson, Henry Hanson, Edward Knemeyer, John Shehady, P. Domeinci, Joe Scurrine, Elmer

Hanson, G. F. Allum, Mrs. Adeline Hilburn, Peter Henricks, Charles B. Johnson, Menesin & Tonetti, Matie F. Fremmel, G. B. Logan, Antone Manha, J. Arouse, Annetta D. Lewis, Peter Heitman, H. S. Morgan, James H. Wichman, John H. Wichman, Mickey Ditch Co. (a corporation), T. F. Fitzpatrick, George Osborne, Mrs. Emma Osborne, H. A. Lancaster, J. M. Lancaster, William Scossa, Joe Scirenia, Frank Luca, Mrs. Melarkey, Pete Dominico, John Perazzo; William Scatena, Louise McGowan, Ray McGown, E. Aeschelman, A. B. Silia, Carlo Barbogetata, Maronchi Bros., Mabel Plummer, George Plummer, Ray McVicar, Neil McVicar, Chas. C. Perry, George W. Freidhoff, Daniel Wilton Pursel, Henry Arthur, Ira Fallon, N. F. Bertrand, Mrs. Sarah Jane Rawlins, William M. Penrose, Mrs. Nellie Neilson, Reynold J. Penrose, Mrs. Mary E. Young, Ambro Rosachi, Thos. Ross, Frank Robinson, W. F. Reading, G. M. Reading, George H. Fulstone, W. H. Roach, Cecil Burkham, Peter Savani, A. Grulli, Frank W. Simpson, Fred Fulstone, Joe Fulstone, Arthur Maionchi, Melio Maionchi, L. D. Santini, Lizzie Heronymous, J. C. Snyder, John Snyder, Gus Williams, Henry A. Williams, Florence Williams, Mamie C. Williams, Dora Williams, Spragg & Woodcock Ditch Co. (a corporation), C. C. Perry, M. F. Bertrand, Mrs. A. F. McLeod, C. A. McLeod, J. B. Gallagher, Mrs. G. W. Webster, S. McCroskey, Lettie Shelton, F. S. Cox, G. F. Willis, G. L. Nicholas, John Lamfersweiler, M. Dellamonica, George Welsh, L. Simmons, W. F. Cambrell, Frank Boward, John Snyder, C. E. Kingsley, H. M. Hanson, J. N. Welsh, J. G. McGowan, Isaac A. Strosnider, F. O. Stickney, Alice L. Martin, Antone Gamagni, the Plymonth Co. (a corporation), Nellie J. Whiteacre, Bertha Ann Johnson, G. W. Wilson, J. Q. Wilson, W. R. McGowan, J. W. Wilson, J. G. McGowan, Mrs. Louise McGowan, Emilio Aiazzi, Hester West, Sophia E. Lynch, John McVicar, F. B. Mann, Margaret Schooley, James T. McKay, John F. Yparraguirre, Frank Yparraguirre, Joseph Yparraguirre, George Parker and John Doe, Richard Roe, Simeon Poe, Jane Doe and Sarah Roe, whose true names are to the plaintiff unknown, defendants.

AMENDED BILL OF COMPLAINT

Comes now the United States of America, plaintiff, by and through George Springmeyer, United States attorney in and for the district of Nevada, and by leave of court files this amended bill of complaint in equity, and complains of the defendants named above, and alleges as follows:

1. That the jurisdiction of this court over this suit depends upon the fact that the United States of America is a party hereto, and that a part of the subject matter hereof is within the State and district of Nevada. The suit is brought on behalf of the plaintiff by direction and authority of the Attorney General of the United States by request of the Secretary of the Interior. That some of the defendants named above, as plaintiff is informed and believes, are citizens and residents of the State and district of Nevada; that others of the defendants are citizens and residents of the State and northern district of California; and that the residence and citizenship of others of the defendants are unknown to the plaintiff.

II. That on November 29, 1859, and for a long time prior thereto, the plaintiff was and ever since has been, and still and now is, the owner of about 86,400 acres of land in the State and district of Nevada, which then formed and now form the Walker River Indian Reservation. That on said November 29, 1859, said lands were largely arid in character and incapable of producing crops without artificial irrigation, but a large part of said lands was then and now is susceptible of being reclaimed and made valuable agricultural land by artificial irrigation. That in said year 1859 a portion of said lands were irrigated and produced crops; that said irrigated lands thereafter gradually were increased in area by the reasonable efforts of plaintiff in building canals and ditches and growing crops thereon, and that now about 2,000 acres have been reclaimed and are producing large and valuable agricultural crops of hay, grain, pasturage, and garden truck.

III. That on or about or before the 29th day of November, 1859, plaintiff having for a long time prior thereto recognized the fact that certain Pahute and other Indians were and they and their ancestors for many years had been residing upon and using certain lands in the State of Nevada around and near the Walker River and Walker Lake, which lands are those mentioned in the second paragraph hereof, and plaintiff then being desirous of protecting said Indians and their descendants in their lands, homes, fields, pastures, fishing, waters, and in their use thereof, and in affording to them opportunity to acquire the art

of husbandry and other arts of civilization, and to become civilized, did reserve said lands with the appurtenances, from any and all forms of entry or sale, and did reserve and set aside the same for the sole use of said Indians, and for their benefit and civilization. That on, to wit, the 23d day of March, 1874, the said lands having been previously surveyed, were by order of the President of the United States of America, for the purpose aforesaid, withdrawn from sale or other disposition and set apart for the Pahute and other Indians aforesaid.

That said Walker River runs through a large part of said lands and a large part thereof, to wit, about 11,000 acres, are susceptible of irrigation from and by use of the waters of the said Walker River and all its branches and tributaries, including the East Walker River and the West Walker River; and for the successful and proper irrigation of and for domestic and other uses on the said land there is now required, and ever since the year 1859 there has been required, 150 cubic feet per second of time of the said waters.

That ever since the said 29th day of November, 1859, and prior thereto, the said Indians and their descendents had lived and they now live upon said reservation; and the same has been used and now is being used by the United States as an Indian reservation and for the uses and purposes aforesaid. The plaintiff does now and for many years last past has maintained an extensive agency and an Indian school upon said reservation, and has encouraged and does encourage the Indians belonging to said reservation, who now number about 520 persons, to farm said lands, and many acres thereof, to wit, approximately 2,000, have been for many years last past, to wit, since about the year 1859, and still and now are being irrigated and farmed by them and used for the purpose of producing extensive crops of hay, grain, pasture, and vegetables.

IV. The United States by setting aside said lands for said purposes and by creating said Walker River Indian Reservation, and by virtue of the matters and things aforesaid, did on, to wit, the 29th day of November, 1859, reserve from further appropriation and did reserve, set aside, and appropriate for its own use in, on, and about said Indian reservation, and on the lands thereof from and of the waters of the said Walker River and its tributaries, 150 cubic feet of water per second of time.

That plaintiff is the owner of and by and through said Pahute and other Indians is in the possession and occupation of the said lands and said Walker Indian Reservation. That plaintiff is now the owner of and by and through said Pahute and other Indians aforesaid, ever since the year 1859 has been the owner and appropriator of and entitled to the use and benefit of a vested water right to 150 cubic feet per second of time of the waters of said Walker River, East Walker River, West Walker River, and all the tributaries of said rivers; and that as plaintiff is informed and believes, and therefore alleges, in said year 1859 plaintiff appropriated and reserved from further appropriation, as aforesaid, and ever since said year of 1859 plaintiff by and through the said Pahute and other Indians has required and has been and still and now is using and utilizing said 150 cubic feet per second of time of said waters for the necessary and beneficial irrigation and reclamation of portions of said lands on said Walker River Indian Reservation.

That the climate where said lands are situated is dry and arid, and that it is necessary to irrigate said lands in order to produce or raise crops thereon; that without irrigation and naturally said lands will not produce agricultural or grazing crops, and are of little or no value, but that with proper irrigation, said lands will produce and for many years last past have produced large crops of hay, grain, pasture, and vegetables. That there is no other source of supply of water for the irrigation of said lands described above than the so-called Walker River, East Walker River, West Walker River, and the tributaries thereof, the waters of which have been used and utilized as aforesaid for the purpose of raising the said crops upon said lands; that in the building of necessary irrigation works including canals, ditches, and laterals, and in clearing said lands for irrigation and in seeding them to crops plaintiff has expended large sums of money, to wit, $175,000, and that if said plaintiff is deprived of the use of said waters upon said lands, the said lands will again become barren and of little or no value, and said irrigation works, canals, ditches, and laterals will likewise be and become almost valueless.

V. That defendants, and each of them, without right and wrongfully and unlawfully, are using and utilizing the said waters of said Walker River, East Walker River, West Walker River, and the tributaries thereof in the irrigation of lands owned or possessed by them, and in so utilizing said waters are obstructing, impeding, and preventing them from flowing down their natural channels to

said Walker River Indian Reservation and are preventing and hindering the plaintiff and the said Pahute and other Indians aforesaid from using and utilizing said waters upon said lands on said Walker River Indian Reservation. The plaintiff is informed and believes and therefore upon such information and belief alleges the fact to be that the defendants and each of them are threatening to use and utilize all said waters upon lands owned and possessed by them, and are threatening to prevent plaintiff and the said Pahute and other Indians from using or utilizing any of said waters upon their said lands in said Walker River Indian Reservation. That the said defendants' said threatened use of said waters is without right, and wrongful and unlawful. That in the event the said defendants or any of them prevent the said waters from flowing to said Walker River Indian Reservation, plaintiff and the said Pahute and other Indians will have no water whatever to supply the needs and requirements of said Pahute and other Indians in the necessary, economical, and beneficial irrigation of the said lands on said Walker River Indian Reservation, and that as a result this plaintiff will sustain great, immediate, and irreparable loss, damage, and injury to its said lands, and that it will be unable to raise or produce crops of hay, grain, pasture, or vegetables upon said lands. That the said defendants threaten, and each of them threatens, and this plaintiff is informed and believes, and therefore upon such information and belief alleges the fact to be that the said defendants and each of them will, unless restrained and enjoined by order of this court from so doing, construct dams, levees, head gates and ditches in said Walker River, East Walker River, West Walker River, and the tributaries thereof, and thereby prevent the waters thereof from flowing naturally to the said lands of plaintiff on said Walker River Indian Reservation, thus preventing said Pahute and other Indians from using and utilizing said waters which are necessary and essential as aforesaid for the proper and beneficial irrigation of the said lands on said Walker River Indian Reservation; all of which will be to the great, immediate, and irreparable loss, damage, and injury of this plaintiff, in that it will be deprived of and will be unable to raise and produce corps of hay, grain, pasture, or vegetables which it has raised and produced upon said lands for many years last past.

VI. That the rights of the said defendants and each of them to the use of said waters of said Walker River, East Walker River, West Walker River, and the tributaries thereof are conflicting with and adverse to the rights of plaintiff as hereinabove set forth, and are conflicting and adverse to the rights of each other and the rights claimed by said defendants, and each of them, if exercised would, and when exercised do, diminish the volume of said waters in said Walker River, East Walker River, West Walker River and the tributaries thereof, so as to deprive the plaintiff of the amount of water to which it is entitled as a vested priority. That in particular during the remainder of the irrigation season of 1926, if the defendants or any of them should use or utilize the waters to which they and each of them claim they are entitled, as plaintiff is informed and believes, and therefore alleges the fact to be, the plaintiff and the said Pahute and other Indians would suffer and sustain a total loss of all remaining crops which could be grown on said lands during the remainder of the season of 1926 if the waters to which plaintiff is entitled are allowed to flow upon said lands, to plaintiff's great, immediate, and irreparable loss and damage.

That until the rights of the various claimants, parties hereto, including the plaintiff, to the use of the waters flowing in said Walker River, East Walker River, West Walker River, and the tributaries thereof in the States of California and Nevada have been settled, and the extent, nature, order, and time of each right to divert said waters from said river and its tributaries have been judically determined, plaintiff can not properly protect its rights in and to the said waters, and to protect said rights other than as herein sought, if they could be so protected, would necessitate a multiplicity of suits.

The plaintiff recognizes as effective and binding the water rights and ditch rights on and along the Walker River and its tributaries in Nevada and in California, which were determined and adjudicated by the final decree of this court in the cause entitled "Pacific Livestock Co., a corporation, complainant, *v.* T. B. Rickey et al., defendants," In equity No. 731, such recognition, however, being binding upon the plaintiff herein, the United States of America, only to the extent that in asserting its own claims as hereinbefore alleged, it will not disturb or interfere with the relative rights as among themselves, of the parties to that decree, or their heirs, successors, administrators, or assigns, who are parties to this suit, that is to say, the parties to said suit In equity No. 731 shall have the priorities and rights adjudicated to them by the decree in said suit In equity No.

731, except that the priorities and water rights of the plaintiff, the United States of America, as they may be fixed and determined by the court, shall take their places in the order of priorities so that the parties to the decree in said suit In equity No. 731, their heirs, successors, administrators, or assigns, who are parties to this proceeding, and whose rights are subsequent to the rights of the United States as they may be fixed and determined by the court herein, shall be subordinate to the rights of the United States. The plaintiff in asserting its own claims by this bill of complaint does not disturb or interfere with the relative rights as among themselves, of the parties to said decree In equity No. 731 or their heirs, successors, administrators, or assigns, who are parties to this suit.

Wherefore, plaintiff prays judgment against the defendants and each of them as follows:

1. That a temporary restraining order forthwith issue restraining defendants and each of them, and their and each of their agents, servants, employees, and lessees, and any and all other persons whomsoever from individually or through others damming, building levees, head gates, or ditches, obstructing, hindering, preventing, or in any manner interfering with the natural flow of 150 cubic feet of water per second of time in, down, along, and upon the natural channels of the Walker River, East Walker River, West Walker River, and the tributaries thereof, to and upon the Walker River Indian Reservation in the State and district of Nevada.

2. That not later than 10 days after the granting of a temporary restraining order a hearing be had and a preliminary injunction be granted to plaintiff restraining defendants and each of them, and their and each of their agents, servants, employees, and lessees, and any and all other persons whomsoever from individually or through others damming, building levees, head gates, or ditches, obstructing, hindering, preventing, or in any manner interfering with the natural flow of 150 cubic feet of water per second in, down, along, and upon the natural channels of Walker River, East Walker River, West Walker River, and the tributaries thereof to and upon the Walker River Indian Reservation in the State and district of Nevada.

3. That upon the trial hereof, a permanent injunction issue restraining defendants and each of them, and their and each of their agents, servants, employees, and lessees, and any and all other persons whomsoever from individually or through others damming, building levees, head gates, or ditches, obstructing, hindering, preventing, or in any manner interfering with the natural flow of 150 cubic feet of water per second in, down, along, and upon the natural channels of Walker River, East Walker River, West Walker River, and the tributaries thereof, to and upon the Walker River Indian Reservation in the State and district of Nevada.

4. That the court order and adjudge that plaintiff has a first and prior vested right to 150 cubic feet per second of time of the waters of said Walker River, East Walker River, West Walker River, and the tributaries thereof, and that the court decree to plaintiff the water rights hereinabove set forth and claimed by and for plaintiff, and quiet its title therein and thereto, and enjoin said defendants and each of them from interfering therewith, and provide such other means, including the appointment of a water master and necessary assistants for the carrying out of its decree herein, as may be proper.

5. That the court by its decree determine the relative rights of the parties hereto in and to the waters of the said river and its tributaries in Nevada and California, both natural flow and flood waters, to the end that it may be known how much of said waters may be diverted from said river by the parties hereto and for what purposes, where, by what means of diversion, and with what priority.

6. That the writ of subpœna issue to each and all of the said defendants, and that they be required to answer this amended bill of complaint, and set up fully their claims to the waters of said river and its tributaries.

7. That plaintiff have its costs herein expended, and such other, further, or different relief as may be meet and proper in the premises.

GEORGE SPRINGMEYER,
United States Attorney, for Plaintiff.

Of counsel:

ETHELBERT WARD,
Special Assistant to the Attorney General.

UNITED STATES OF AMERICA,
District of Nevada, ss:

George Springmeyer, being first duly sworn, deposes and says:

That he is the United States attorney for the district of Nevada, and as such makes this verification for and on behalf of plaintiff. That he has read the above and foregoing amended bill of complaint and knows the contents thereof; that the same is true of his own knowledge except as to the matters therein stated on information or belief, and as to them, he believes it to be true.

GEORGE SPRINGMEYER.

Subscribed and sworn to before me this 19th day of March, 1926.

[SEAL.] ANNA F. WARREN, *United States Commissioner.*

WALKER RIVER STORAGE INVESTIGATIONS

SUPPLEMENTAL REPORT

ON

RIO VISTA RESERVOIR

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Maps and drawings contained in this report are not printed in this publication.

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LETTER OF TRANSMITTAL WITH SUMMARY AND RECOMMENDATIONS

DEPARTMENT OF THE INTERIOR,
UNITED STATES INDIAN IRRIGATION SERVICE,
SUPERVISING ENGINEER,
Blackfoot, Idaho, February 14, 1927.

COMMISSIONER OF INDIAN AFFAIRS,
Department of the Interior, Washington, D. C.

DEAR SIR: On December 29, 1926, we transmitted a report with preliminary plans and estimated cost on the proposal to construct a storage reservoir for the irrigation of Indian lands on the Walker River Indian Reservation of Nevada, as provided for by act of Congress, approved June 30, 1926. (Public, No. 442, 69th Cong., S. 2826.) It was then stated that the investigation of the proposed dam site had not been completed, and that a supplemental or final report, with more detailed plans and revised estimates of cost, would be submitted after completion of the exploratory and investigational work.

It is believed that all the surveys, explorations, and tests necessary for ascertaining the feasibility of the proposed dam site, for indicating the type of structure demanded, and for determining as nearly as possible the approximate cost of the storage development have now been completed, and the following report, supplementary to that of December 29, is respectfully submitted:

The necessity for storage facilities in connection with the irrigation project of the Walker River Indian Reservation, in order to assure a safe and dependable all-season water supply for the Indian lands, has long been recognized, and at various times for several years preceding the present investigations, as funds and time have been available, the question has been the subject of considerable study, including extensive surveys and field investigations. These earlier investigations, however, failed in the discovery of a satisfactory storage site within or near the reservation, and, moreover, seemed to establish it as a fact that no such site existed other than the so-called Weber site, which has so many objectionable features in addition to its inadequate capacity that it can not be considered as feasible. As a result of this failure to find a suitable storage site on the lower Walker River or within the reservation, some consideration was for a time given to the proposition of acquiring by purchase a feasible site on the upper river and constructing a reservoir. Later the advisability of cooperating with the Walker River irrigation district, then recently organized, in the construction of a reservoir at Bridgeport or Alkali Lake, or the purchase of the required storage in one of these reservoirs to be constructed by the district, was considered. It was,

of course, realized by the engineers who offered these various plans that a storage reservoir at so great a distance from the point of use—especially because of the unfavorable conditions existing in the river channel through which the water of necessity would have to be conveyed—would be very unsatisfactory, but such plans then seemed to offer the only possible solution of the problem.

As a result of the inadequacy of the water supply during the past few years—and especially the season of 1924, when no water was available after June 15, and the crops of the Indians were almost a total loss, and there was in consequence much hardship and suffering among them—the necessity for storage, or an increased water supply, has become increasingly apparent and urgent. Efforts with the hope of discovering a storage site that might prove feasible were accordingly renewed. All of the sites that had been previously considered and investigated were again carefully inspected and studied, and several new ones holding out some promise of feasibility were discovered, but funds were not then available for the necessary investigations to determine the question of their feasibility. Such funds were finally provided by the present appropriation of $10,000 carried in the act of June 30, 1926.

With the funds thus provided very extensive and careful surveys and explorations have been made, and these have definitely determined the fact that there is but one feasible and practicable storage site of adequate capacity for our purposes within the reservation, or in fact on the lower Walker River. This is the one we have denominated the Rio Vista site—it was first brought to our attention by Mr. E. W. Kronquist in the winter of 1925–26. Preliminary explorations soon developed the fact that the Rio Vista site is so far superior to all others that it was possible soon after beginning the recent investigation to eliminate the others and confine our efforts to the explorations necessary at this site. Mr. W. E. Blomgren was in immediate charge of the investigations and prepared the following report:

PLAN OF PROPOSED DAM AND ESTIMATED COST

It is proposed to build an earthen dam 58 feet high, which will be approximately 900 feet long at the base and 1,560 feet long at the crest. This will create a storage reservoir with a capacity of 30,000 acre-feet when filled to the level of the spillway. The crest width of dam is 20 feet, and the slopes 3 to 1 upstream and 2 to 1 downstream, and the extreme base width approximately 300 feet. The spillway is 360 feet long, with a spillway capacity at maximum high-water elevation of 23,400 second-feet. The maximum flood of record at Wabuska is 3,200 second-feet and at Coleville 5,000 second-feet. The area submerged at maximum high water is 2,900 acres, nearly all of which is useless for other purposes. The spillway site is in an extensive intrusive dyke of andesite which outcrops at or near both ends of the dam, being continuous at varying depths below the stream bed and narrow flood plain for the entire length of the dam.

In the present report, as in our previous report, four plans for the proposed dam are submitted, as indicated on drawing 5A (file No. W. R.–47) in the accompanying folder. (See also drawing 5 of the

previous report.) Since plan or design No. 2 is in effect the same as design No. 1, except for the location, in elevation, of the upstream impervious apron, and as the cost of excavating for this upstream apron would be excessive, design No. 2 has been abandoned and no cost estimate based upon it is submitted. Cost estimates are submitted on designs Nos. 1, 3, and 4 of drawing 5A, and also on various modifications of these as explained in connection with the estimates. It is our judgment that any one of these three designs, if properly followed out, will give an entirely satisfactory and absolutely safe structure. Design No. 3, for a height of 58 feet and with clear or uncontrolled spillway, is favored by the writer and is accordingly recommended. The estimated cost is $307,764, or approximately $310,000, which for its capacity of 30,000 acre-feet gives a unit cost of $10.30 per acre-foot, which is considered very reasonable. My second choice would be a modification of design No. 3, with steel-sheet piling in the river sand between stations 13 and 18 of section A–A, of drawing 6C, file No. W. R.–51, which in our estimates is denominated "Dam Design No. 5 (Revised)." The estimated cost of this is a little less than $300,000.

NECESSITY FOR STORAGE

The success of any irrigation project depends primarily upon the delivery of water to the land in such quantity and at such times as needed for the production of crops. Nothing imaginable can be more disheartening than trying to farm in an arid country without a safe and dependable water supply. If the supply fails when the crop is well along toward maturity, it usually means partial if not entire loss of the seed and the farmer's labor for the whole season.

It is frequently said, and in fact it is characteristic of not a few Indians as well as some whites, that they have an aversion to hard work and that they lack perseverance. But the manner in which the Indians of the Walker River Reservation continue to work their farms and support themselves, despite the numerous crop failures they have experienced as a result of the failure of their water supply, proves that they are industrious, patient, and persevering to a most unusual degree. It is not believed we have in the whole country any Indians more deserving of assistance and encouragement than these, or any who will make better use of any opportunities afforded them. Almost any other people—white or Indians—subjected to the same experience would have given up long ago in despair.

The question arises as to whether, if the Indians are decreed a water right of first priority, storage will be required. Stream flow in a river system such as the Walker River is an extremely complicated problem, being affected by innumerable continuously varying factors. As indicated in our previous report, it would be impossible under present conditions existing along much of Walker River, especially the numerous crude and bunglesome diversions in Mason and Antelope Valleys, and the inefficient and unsatisfactory methods of river management and control, to carry on with any degree of accuracy the investigations necessary for even an approximate determination of stream losses, return flow, lag, etc. Even under satisfactory conditions such investigations to be of value would of necessity have to be extended over a period of several years. This

work accordingly was not attempted as a part of the present investigation. The problem in this case would be to determine as closely as possible the stream flow of Walker River at the reservation diversion point as it would exist if natural conditions in the upper valleys could be restored; that is, if no agricultural development existed above the reservation, and the same conditions existed as at the time the reservation was established.

Taking the records available and interpreting them in the light of experience, it is my judgment that even though it were possible to restore natural conditions—that is, blot out all development on the river above the reservation—the uncontrolled stream flow would be adequate for the the full-season irrigation of the total irrigable area (10,000 acres) of the reservation only one season of every two. Referring to the records of stream flow, pages 29 and 30 of our previous report, and assuming a 50 per cent loss in transit through the river channel, which is believed conservative in view of physical conditions, it is found that there would be available at the Indian diversion point during the months of August and September less water than the 150 second-feet that is considered necessary for 11 years of the 22-year period from 1903 to 1924, inclusive, as shown by the table on the following page.

This table shows the estimated discharge of Walker River at the reservation diversion point, assuming there were no other diversions and a 50 per cent loss from the junction of East and West Walker Rivers, for August and September of the years 1903 to 1924, inclusive, when the discharge thus computed would have been less than the quantity required for the irrigable area of the reservation (10,000 acres) or 150 second-feet.

Year	Estimated discharge at reservation diversion		Year	Estimated discharge at reservation diversion	
	August	September		August	September
1903	95	69	1918	106	93
1905	93	67	1919	91	59
1908	124	70	1920	99	80
1912	93	71	1921	119	75
1913	148	106	1924	15	17
1915	116	72			

If the Indians are decreed a water right of first priority for 150 second-feet for 10,000 acres, and should shortly thereafter increase their cultivated area from what it now is to 4,000 acres, as they probably would, they will then be entitled to 60 second-feet at their diversion point. The above tabulation indicates that this amount would be available from the normal or natural flow, providing there are no prior rights or diversions, for practically every year but one of the 22-year period. If we should include the years 1925 and 1926, there would be two years (1924 and 1926) in the 24-year period when the supply would have been insufficient to meet the required 60 second-feet under the conditions assumed. Ordinarily, even under natural conditions, there would be a return flow from areas flooded or saturated during the early spring run-off, and this would tend to

increase the stream flow during the latter part of the season. Walker River, however, being an alluvial stream, with the land adjacent to its channel at the same or a greater elevation than the land along the margins of some of its lower valleys, which especially is true of Mason Valley, without deep drainage there would be but little return flow.

It seems apparent from the foregoing that if the Indians are decreed a water right prior to all others on the river, and such right is enforced, that for any cultivated area less than 4,000 acres there is no necessity for storage except as an economic measure for benefiting the entire community.

The excessive water loss in the channel of the lower Walker River, which would be obviated by storage at a point near the Indian land, is indicated by the fact that although, on one occasion during the past irrigation season 320 acre-feet was actually delivered in the river channel below all diversions above the Indian Reservation, only 80 acre-feet finally reached the Indian diversion dam 35 miles farther downstream. It is true, of course, that this is not a fair index of the loss, as the river channel had been dry for a considerable period of time. Taken in connection with rather extensive studies and investigations of conveyance losses made by the writer under somewhat similar conditions, it is believed that it would be conservative to estimate the loss in the 35 miles of river channel between the Indian diversion and the lowest upstream diversion at 35 per cent.

It must also be borne in mind that it is impossible to so regulate the river flow that the required quantity of water, if available, will be delivered at a diversion point so far downstream from the other diversions. There will of necessity be periods of excess flow and consequent waste of water as the result of the impossibility of adjusting the stream flow to comply with a fluctuating demand at a downstream diversion point. These objectionable conditions would, of course, be removed by a storage reservoir near the diversion.

Setting aside theoretical considerations respecting the conditions of stream flow and the amount of water that may have been available for the Indians at the time Walker River Reservation was established, and taking conditions as they now exist, it is a matter of record that for many years, with but few exceptions, little or no water has been available for the Indians during the latter half of the irrigation season. Farming under such conditions can not be successfully carried on by any one. As early as 1898 (see report of L. A. Ellis included in previous report) it was reported that "there was no water after July 10, and the quantity was insufficient for about two weeks preceding that date." Reference is also made to the report of 1906, by former Chief Engineer W. H. Code. It will be noted (see General Summary of Irrigation Data—Water Supply) that during the 11-year period 1916 to 1926, inclusive, there were but two years—1922 and 1923—when there was sufficient water for irrigation during the entire season. It will also be noted from the crop valuation record for various years that the average total valuation for years of fairly sufficient water supply is approximately $60,000, while for low-water years it may be reduced to about $20,000. It is thus believed conservative to state that with an adequate water supply the Indians' crop production would on the average be increased by fully 50 per cent for each and every year,

or approximately an increase of $20,000 per year on the average area cultivated during recent years. Moreover, it should be borne in mind that were it not for the usual water shortage, and were it not for the fact that the superintendent of the reservation and irrigation officials have for many years consistently discouraged the improvement of new lands because of the deficiency in the water supply, it is apparent that the cultivated area would be at least twice what it now is.

The urgent necessity for storage as a result of existing conditions has been so well and so elequently set forth by the Indians in their petition of 1919, addressed to Congress through the Secretary of the Interior and the Commissioner of Indian Affairs (see p. 51 of previous report) that we quote therefrom as follows:

> This is most important that we must have a storage dam. It is the cry of all these Indians and it is needed to save us. Our superintendent and the supervisors of irrigation have written you of the cost and of the great benefit to us and the Government. Now, we have about 1,300 acres that has cost $100 an acre, and water fails us in the early part of July, causing much loss. With the storage dam we have nearly 7,000 acres that could be irrigated and the total cost of all would be less than $50 an acre, and water would be supplied through July, August, and September, saving one or two hay crops and our gardens and pastures.
>
> Every superintendent who has been with us has urged the building of the storage dam—all say it is our salvation. We Indians have waited, but without success; our crops dry up early in summer and our stock suffers. Our Indians are afraid and discouraged, but with the dam and water sure we would take heart and our reservation and the whole valley would prosper. Most of our Indians now have to go away to work to make the money to live, which is bad for them and their children.

ADJUDICATION OF WALKER RIVER WATER RIGHTS

Court action, with a view of determining the water rights of the Walker River Indians has lately been initiated. It is the hope that this action will result in a decree granting the Indians a right of first priority for any area they may at any time have in cultivation up to the limit of the irrigable area of 10,280 acres.

With the hope of avoiding long and expensive litigation and of expediting the adjustment of the questions at issue between the Indians and the upper river water users, we suggested in our previous report the possibility of an agreement by stipulation that might be incorporated in a court decree. In view of the principle established by the United States Supreme Court in what is known as the Winters decision, and the decree recently rendered respecting the water rights of the Pyramid Lake Indians on the Truckee River, it is believed that the Walker River water users must realize that there is a strong probability that litigation will result in a decree favorable to the Indians, and accordingly may not be averse to conceding to them a prior right.

HOW SHALL STORAGE DEVELOPMENT BE FINANCED?

As indicated in our previous report, the cost of the proposed storage, if assessed against the area benefited—the total irrigable area (approximately 10,000 acres) of Indian land—would result in a very reasonable per acre cost as compared with the benefits derived and as compared with other Government or private projects having equal

advantages in this part of the arid country. The total per acre cost of the Indian project in its present condition, with 3,600 acres susceptible of irrigation from the system as now constructed, and under existing conditions, with an inadequate and not infrequently no water supply whatever and frequent resultant crop failures, is $36. The estimated cost of the completed project, including the storage reservoir, for serving the entire irrigable area with an adequate and dependable water supply is $53 per acre. It is apparent that land with an adequate full-season water supply at $53 per acre or even at $75 or $100 per acre is a better investment than the same land with but a partial water supply at $36 per acre.

It is not probable that more than 4,000 acres will ever be cultivated by the Indians now on the Walker River Reservation. This will leave about 6,000 acres that should be leased, providing an adequate water supply is developed. With so large an area leased and with some such method of repayment of construction costs as is now in practice on the projects of the Bureau of Reclamation, whereby the annual payments, being a small per cent of the crop value produced, would be spread over a period of 40 years, reimbursement of the Government by the Indians should be a comparatively easy matter and should occasion no hardship.

If, however, the Indian has been wrongfully deprived of his water by the incursions of the white settlers on the upper river, and the court decrees him a prior right, it would be an injustice to require him to build a storage reservoir for the irrigation of whatever area he can successfully irrigate from the normal flow of the river, unaffected by diversions of all subsequent appropriators.

As previously pointed out, it appears from the records of stream flow that the normal flow of the river—not considering abnormally dry years that occur only at long intervals—is sufficient for the irrigation of approximately 4,000 acres. Consequently it would seem that this area of 4,000 acres should be provided with an adequate all-season water supply without being obligated to pay for the development of storage. Assessing the entire cost of storage to the remaining 6,000 acres would give a per acre cost for storage alone of approximately $50. Adding to this the per acre cost of the irrigation system, the total per acre cost for this 6,000 acres would be about $75 per acre, which is still reasonable as compared with many other projects, both Government and private.

If the right of the Indians is prior to all others, and if, as seems evident from the stream-flow records, the normal flow is sufficient for the irrigation of 4,000 acres of Indian land, it would seem advisable from an economic standpoint for the upper river water users to participate in the construction of the proposed Rio Vista Reservoir, thus in effect providing stored water for Indian lands in lieu of normal flow water. In this way the transmission loss, which is especially great during the middle and latter part of the summer, could be prevented, and the saving thus effected would be a direct benefit to the upper river users. This suggests a plan whereby the upper river users would pay 4,000/10,000, or four-tenths, of the cost of the proposed storage development, and in return would receive during each irrigation season that part of the normal flow that would otherwise be required for the irrigation of 4,000 acres of Indian land.

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It will be noted that the plan first suggested—that of assessing the cost of storage against the entire irrigable area and completing the irrigation system—will make the total project cost about $53 per acre. In this connection attention is called to the fact that the Walker River Valley was at one time considered as a possible United States Reclamation Service project. (See references and excerpts from the report of J. C. Stevens included in our previous report.) The estimated cost of the project as contemplated by the Reclamation Service, including 10,000 acres of Indian reservation lands, but with a storage reservoir on the reservation of only 9,700 acre-feet, is $54 per acre. It appears that the only thing that prevented the beginning of this project by the Reclamation Service was the failure to bring about an agreement relative to the pooling of water rights. It is believed from an examination of the Stevens report that the cost estimate, like many others prepared about that time, is low, and that the cost of the project as outlined would have considerably exceeded the estimate. Had this project been built, the cost to the Indians would have been in all probability considerably higher than the development now proposed.

RECOMMENDATIONS

In conclusion, the following recommendations as made in our previous report are renewed:

(1) That water rights be adjudicated at the earliest possible date.

(2) That the entire river system be placed in charge of a water commissioner appointed by the Federal court, with instructions to require the installation of suitable weirs, head gates, and measuring devices by all diverters.

(3) That a storage reservoir be created for the Indian land of Walker River Indian Reservation by the construction of a dam at the Rio Vista site, and that the irrigation system be extended to cover the entire irrigable area of the reservation.

Very respectfully,

C. A. Engle, *Supervising Engineer.*

WALKER RIVER STORAGE INVESTIGATIONS

Supplemental Report on Rio Vista Reservoir

In the report submitted December 29, 1926, the necessity for a reservoir for the Walker River Indian Reservation was discussed and conclusions set forth favoring the development of the Rio Vista Reservoir as the most practical storage site on the reservation.

Since submitting the above report field investigations have been completed, and the results of test borings are shown by three cross sections of the river channel on a drawing submitted with this report. There is also submitted a drawing showing plan and details of the outlet works. The results of all tests made are shown in tabular form, with the discussion regarding these.

Estimated costs of construction have been studied and revised estimates are herewith submitted.

DAM DESIGN

Earth dams have seldom been designed by the application of theory and the laws of mechanics and hydraulics. The design of an earth dam is largely a matter of judgment with the application of a few fundamental mechanical principles, the designer being governed largely by the results of experience and designs of dams that have stood the test of time. A great many theses and discussions have been written by engineers in an attempt to formulate some standards, present formula, and advance criteria for the design of earth dams, but a review of all published works with their criticisms indicates that the opinion of the world's best authorities along this line is quite variable and not in agreement.

The design of any particular earth dam is then largely a matter of judgment, governed by local conditions and guided by established practices of engineers under similar conditions.

The following criteria have been advanced, and it is fairly well established that an earth dam should be designed so that—

(1) The spillway capacity is so great that there is no danger of overtopping.

(2) The line of saturation is well within the downstream toe.

(3) The upstream and downstream slopes must be such that with the materials used in construction they will be stable under all conditions.

(4) There must be no opportunity for the free passage of water from the upstream to the downstream face.

(5) Water which passes through and under the dam must have, when it rises to surface below the toe, a velocity so small that it is incapable of moving any of the material of which the dam or its foundation is composed.

(6) The freeboard must be such that there is no danger of overtopping by wave action.

Observation of irrigation and hydraulic construction and experience in operation has demonstrated, in my opinion, that the most stable embankment is one constructed of sand and gravel with an impervious barrier to the water, either placed on the water side during the construction or by process of silt deposits from the stream. Guided by these observations in the design of any dam, no matter what the type or material, there should be due regard for what some engineers term the "great hydraulic principle—provide a more or less impermeable barrier to the water and a more or less unyielding support, possibly pervious, for this barrier." Earthen canal banks are dams in principle if not in practice. In many cases both bed and bank are of gravel. They leak at a great rate when first put in service, but soon stanch with silt, and in time become reasonably water-tight. They are good illustrations of the great hydraulic principle—a thin more or less impermeable layer of silt-stanched gravel supported by a more or less unyielding but quite pervious bank of gravel.

The conditions governing the construction of the dam are, first, provide for adequate drainage and stability by constructing the downstream portion of the embankment of coarse, easily drained material; second, provide an impervious barrier on the upstream face of the dam or as far upstream as conditions will permit with adequate provision for stability and protection from wave action; the path of percolation through the dam will then be well within the upstream portion of the dam section. The dam itself is then safe. If seepage or percolation below the base of the dam can not economically be prevented by the construction of cut-off walls, or trenches carried down to the underlying impervious strata, then seepage or percolation must be reduced so that the velocity of the moving percolating water is incapable of moving particles composing the dam foundation. In other words, the path of percolation is lenghtened so that the head is dissipated in friction, and percolating waters issue downstream as merely seeps or imperceptible flows.

Mr. Gardner S. Williams, consulting engineer, of Ann Arbor, Mich., in his discussion on earth-dam design, states "that in his practice he has found it more economical and entirely satisfactory to control the position of the line of saturation within an earthen embankment by drains rather than by a core wall or puddle core, or by the addition of material on the downstream slope.

From the application of physical laws, it is evident that at the surface of saturation there can be no water pressure normal to that surface, and, therefore, theoretically, a permeable earthen embankment having a surface corresponding to the line of saturation would be in equilibrium. The superincumbent material consequently creates the factor of safety of the structure. It probably has a small effect also on the position of the surface of saturation, because its weight consolidates the saturated material under it, and hence increases the resistance to flow through it and the hydraulic gradient of the passing water. If the surface of saturation be made to pass from the water surface in the reservoir to an intersection with the original ground surface at or near the center of the dam, a thoroughly stable structure results. This may be readily accomplished by extending a tile drain, covered with small boulders and gravel, longitudinally along the

foundation, at or near the center line of the embankment, and by laying lines of transverse tiles, connecting with this drain, at frequent intervals, and similarly covered to a trench just outside the downstream toe from which the percolating water may be carried away.

This method has been used with uniform success for the past 10 or 15 years in embankments built with such sands as are found in northern Wisconsin and Michigan, of loam sand, gravel, and stones. Where sorting is possible, it is desirable to cover the upstream slope of the embankment with the denser material for a depth of 3 or 4 feet or more, and build the remainder of the structure of more porous material.

By this method of construction the volume (and consequently the cost) of the embankment can be reduced considerably, as ordinary materials will stand safely at slopes 1 on 1½.

The quantity of water collected by drains will usually decrease rapidly after a few days' flow and in time will become almost nothing.

Experiments on the flow of water through embankments indicate quite clearly that no formula for flow can be applicable permanently, because the banks tend to close their pores under the influence of the water passing through them, and thus greatly increase their impermeability.

Safety in a dam is not always obtained by tightness. Making it tight in the wrong place is more dangerous than leaks.

The Mackay Dam on the Lost River in Idaho, constructed of rock and gravel on a gravel stream bed, when first constructed had leakage as high as 50 second-feet, with a total leakage from the reservoir basin as high as 135 second-feet, with 50 feet of water behind the dam. The citizens of Mackay, Idaho, fearful as to the safety of the structure, were successful in having State authorities stop construction when the dam was 68 feet high. The seepage flow has decreased yearly, and now water users lower down on the river are protesting that the dam is stopping return seepage flows to the river and depriving natural river-flow users of normal river waters. The designer of the dam has recommended the sluicing of a blanket on the upstream face should the Utah Construction Co., owners of the structure, ever desire to cut off the seepage flow. No erosion from issuing seepage waters has been noticed below the downstream toe of the dam.

The hydraulic-fill method of construction is recommended for the proposed Rio Vista Dam, because it is believed that conditions are favorable at this site for transporting and compacting material in dam by water, more economically than by mechanical methods; and also, it is considered that the hydraulic method is the best method of compacting coarse material. In these days of high labor costs, the hydraulic-fill method of construction should be given careful consideration in proposed embankment construction.

The hydraulic-fill method has been criticized recently by many engineers on the grounds that there have been many failures of dams constructed by this method. A search of the published data on dam failures, reveal only two notable failures of hydraulic-fill dams, viz, the Necaxa Dam in Mexico, and the Calaveras Dam in California. Both of these failed during construction, principally because too fine material was used in the central core. The core fill remained in a fluid state, and the toes of the dam were not heavy enough to resist this lateral fluid pressure, consequently the outside coarser material

was pushed out of place and portions of the dam cores slipped or slid out. Several minor failures have been reported, the slides being due to the fact that the downstream portion of the dams were clay fills which did not permit proper drainage, retaining water in the dams, which eventually became saturated. The principal cause of earth dam failures has been the overtopping of dams, due to insufficient spillway capacity.

RECOMMENDED DESIGN

Design No. 3, on drawing No. 5–A, file W. R. 47, is recommended by the writer, as the most economical and practicable, because, first, it provides for more effective downstream drainage, the principal consideration for stability; the surface of saturation will intersect the base nearer the center of the dam in this design than in any of the others. Seepage through the foundation is an accepted condition, and drainage is an important consideration. Second, the greater part of the embankment is hydraulicked material and it is believed can be placed more economically than in the other designs. The material will be sorted automatically by the sluicing operations, the coarser material being dumped at the rear and the finer material being carried to face of the dam, where desired. Experiments during construction will determine whether the blanket on the upstream face can be placed by hydraulicking. It is now proposed to place the blanket mechanically, carrying excavation a little in advance of sluicing, using the face blanket as a barrier for the fines from sluicing operations. Flumes or boxes through the face blanket will carry off water and excess fines which will be deposited in the pool above the dam forming the upstream blanket. By this method the river bed above the dam will be sealed, and the upstream blanket placed with but slight additional cost. It is difficult to analyze this cost, but under this method it should not exceed 20 cents per cubic yard.

It is not considered necessary to use sheet piling below the cut-off trench; the upstream blanket is just as effective and much cheaper. From the experience in driving small casing for test borings, it will be extremely difficult to drive sheet piling. Piling will be shattered and spread at the base by boulders, and a doubtful seal obtained.

Regarding the use of the upstream blanket, C. H. Paul, formerly chief engineer for the Miami conservancy district, who constructed the large earth-fill dams for this work, states: "More emphasis might be given to the use of an impervious upstream blanket to join the impervious part of the dam in order to lengthen the line of seepage travel or to lower the line of saturation. In many instances this may be more effective than core-wall construction and much cheaper. Moreover, in case it may be desirable, it provides a simple and effective means of future extension. In the design of the five hydraulic-fill dams of the Miami conservancy district it was decided that the upstream blanket was more practicable than core walls, and that it provided a very satisfactory method of controlling seepage under the dam. At the site of each of these dams there was a layer of fairly impervious material overlying the sand and gravel in the valley floor, except in the river channel itself. * * * It was necessary then to place a complete blanket across only the river channel itself. On a pervious foundation, when the core wall or sheet piling will not cut off seepage but can only lengthen its line of travel,

the upstream blanket is to be recommended as an economical and effective substitute. Its effect on the line of saturation is no less positive."

In dam design No. 3 the percolation gradient (from Bligh) is shown as 10:1. From the study of the foundation material it is believed that a gradient of 7 or 8 to 1 would provide ample distance for the dissipation of the seepage head. The sands are very tight and the rate of percolation very slow through them. The added weight of the dam above the foundation will further compress the sand, decreasing porosity and increasing impermeability. In any event, the 10:1 gradient affords a high factor of safety.

In the other designs it is believed that a percolation gradient of 10 to 1 or 12 to 1 would be sufficient, and estimates are made accordingly.

Dam design No. 1 is very safe and conservative construction, but because of central core would not have as effective drainage as in design No. 3. The cost of placing the core material mechanically will add to the cost.

Design No. 2 might be classed as ultraconservative. It is not believed that conditions require the safety that is provided by this design. The added expense of stripping foundation and removing river sand will be excessive and not necessary to provide a safe storage dam. Estimates on this design are omitted from this report.

Design No. 4, requiring the construction of a downstream blanket, is excellently suited for conditions at this site, but the quantities in the dam are greater than in the other designs and the construction cost higher. The cost of placing the loose rock fill will also add materially to the cost. In order to secure this additional quantity of loose rock much more drilling and blasting will be required, whereas it is believed that the quantity of rock required in other designs can be secured with but very little drilling and blasting.

The whole subject of the design and construction reverts to the fundamental fact that the engineers in charge must have a thorough understanding of the nature of the materials which are to be used in the dam, and appreciate the practical limitations in the use of these materials.

In earth-dam construction, it is well to stress the importance of proper engineering supervision during construction. Too much can not be said about the necessity of good judgment and experience in investigations and designs for any important structure of this kind, and all may be wasted unless intelligent engineering supervision is furnished during construction.

FOUNDATION CONDITIONS

As was mentioned in the preliminary report, test borings indicate that the rock outcrop at the west end of the dam, the proposed spillway location, is probably a portion of an intrusive dike of andesite that extends across the river to the northeast and under the upstream toe of the dam. In the center of the river this rock was found at a depth of 42 feet and near the east bank at a depth of 18 feet. (See cross section A–A, drawing No. 6C, file No. W. R. 51.) On the line of the proposed axis of the dam (shown by section B–B, drawing No. 6C, file W. R. 51) nothing but sand was found for a depth of 45

feet, as deep as it was practicable to go in sand with the drilling apparatus used. A study of the cross sections will indicate that the most favorable location for the dam cut-off would be just downstream of the upstream toe or along the line of section A–A. In the river bed the first 10 or 12 feet consists of rather coarse river sand; below this depth the sand becomes finer with varying amounts of clay or silt disseminated through it. An analysis of samples secured with a drive pipe from holes Nos. 34, 40, and 42 (sec. A–A), indicate that the clay content of the samples was from 5 to 10 per cent by weight. From these tests an approximate grading of the sand and clay is shown on the cross section. The analyses shown on pages following indicate that the sand is very fine, the effective size (the size of the sand particles such that 10 per cent by weight is finer than it) is from 0.10 to 0.25 millimeter; and that generally approximately 60 to 80 per cent of the sand is as fine or finer than 0.589 millimeter (No. 28 sieve). Percolation tests indicate that the material is quite impervious.

Applying the Slichter formula to this material and using the effective size and porosity as determined from mechanical analyses, the total flow under dam with a depth of 53 feet in the reservoir would be only 0.122 second-feet as follows:

$$Q = K\frac{p\ s}{h}$$

in which q = discharge in cubic feet per minute;
p = difference in pressure loss of head in feet;
h = length of soil column in feet;
s = area of cross section of soil column in square feet;
K = transmission constant determined experimentally depending upon effective size and porosity.

NOTE.—Formula developed by Professor Slichter in experiments on the movement of underground water through soils and subsurface formations. Based on Darcy's Law of 1858,

$$V = K\frac{p}{h}$$

From Water-Supply Paper No. 67, U. S. Geological Survey, also Water-Supply Paper No. 140, U. S. Geological Survey.

According to the above, taking the area below the cut-off trench and above the rock as 4,270 square feet and the length of percolation as 300 feet (the base of the dam), with 53 feet of water in the reservoir, porosity 34 per cent, and the effective size as 0.14 millimeter—

$$Q = 0.0097\ \frac{53 \times 4{,}270}{300} = 7.32 \text{ cubic feet per minute, or } 0.122 \text{ second-foot}$$

Considering a unit area and the porosity as 34 per cent, the actual water velocity is—

$$Q = 0.0097\left(\frac{53 \times 1}{300}\right) = \frac{0.00171}{.34} = 0.0051 \text{ foot per minute}$$

Using the extreme limits of the sand, with an effective size of 0.25 millimeter and a porosity of 40 per cent, K = 0.053, the velocity would be—

$$Q = 0.053\left(\frac{53 \times 1}{300}\right) = \frac{0.00935}{.40} = 0.023 \text{ foot per minute}$$

Engineers who are responsible for the development of these formulas state that too much reliance can not be placed upon the results obtained by their application to earth dams, but state that they may serve as a guide to the engineer's judgment when other conditions of design have been fulfilled. The laws of seepage through mixed and clayey materials may be similar to those of sands, but the difficulty in applying these laws to earth dams and dam foundations lies in the determination of the transmission constants. The effective size of the soil particles and their porosity is quite variable and they can not be determined exactly by a few mechanical analyses.

In making test borings in the river bed, holes were put down by the wash-boring method, and a pipe casing driven down following the washing out of hole. Before beginning each washing operation samples of material were secured by inserting a smaller pipe in the casing and driving the pipe into the material to be sampled. The samples from the drive pipe were analyzed mechanically and the porosity measured. In their natural position in the river bed the porosity, due to the degree of compactness and compression by weight of overlying material, would no doubt be less than that determined in the experiments.

The rate of percolation was measured by placing a layer of the material in 6-inch diameter pipe and the material kept under a constant head, and percolation measured for a certain time interval. At the bottom of the standpipe, which was sealed except for a small pipe outlet, was placed a screen, and upon this screen a 4-inch layer of graded filtering material, graded from coarse at the bottom to the fines at the top. Upon this filter layer was placed the material to be tested. The thickness of the material tested varied from 1 to 1½ feet. While making the low-head tests the top of the standpipe was left open. In making the high-head tests the top of standpipe was sealed and connected with the local water system. The maximum pressure of the local water system was 25 pounds per square inch, equivalent to about a head of 57 feet. At the top of the standpipe, with samples of loose material, 16 pounds per square inch was the maximum head obtained. When the material was tighter this pressure went up.

The mechanical analyses and tests are tabulated on pages following. In our studies so far we have been unable to get any consistent results by the application of these percolation tests to the laws and theories on this subject. In event that funds are provided for the dam construction, studies may be continued and some definite results obtained that might suggest advantageous modifications during construction.

While putting down the test holes the pump was attached to the casing and pressure applied in this manner. Surprisingly high pressures were obtained at the gauge on the casing with very small quantities of water pumped. With the maximum pressure of 200 pounds per square inch, or a head of 461 feet, the rate was 1½ gallons per minute; with a head of 145 feet the rate was 0.60 gallon per minute. Because of area of application being indeterminate these tests could not be applied to seepage formula. However, the tests are a good indication of the resistance of the river-bed material to piping and blow-outs.

A fine sand that flowed into the pumps was encountered at the bottom of hole No. 35 on top of the rock, but with the protection of heavier overlying material and the compression obtained by the added weight this condition should not cause any concern. This hole was an open pit, and there was considerable space between the rock and the bottom of the lagging that permitted the sand to flow in when the large diaphragm pump was put in action. A sample examined contained a considerable quantity of quartz and feldspar grains, which would indicate the material was not quicksand.

All tests indicate that the sand below the river-bed sand is very dense and contains varying amounts of clay. Samples from the drive pipe, while having the general appearance of sand, would dry in lumps, indicating the presence of some binding material. The percentage of clay was determined by elutriation in graduated tubes or beakers.

Since making tests and observing conditions at the dam site, the foundation conditions are, in my opinion, absolutely safe for the structure, and there should be no excessive amount of percolation under the dam, with piping or blow-outs. The upstream blanket will effectually seal up the river bed, increasing the length of percolation, and the resistance of the material will dissipate the head by friction in a short distance, providing an additional factor of safety for the proposed structure.

SPILLWAY

According to the records of the United States Geological Survey, the total drainage above the reservation, or above the Wabuska rating station, is 2,420 square miles. The maximum recorded flood run-off at Wabuska is 3,200 second-feet, or about 1.32 second-feet per square mile. During the same flood the maximum flow at Coleville, Calif., on the west Walker River, was 5,000 second-feet. In the proposed designs the spillway capacity, with the spillway crest at elevation 4,291 and a depth of 7 feet over a crest length of 360 feet, is 23,400 second-feet based on the Francis formula ($Q = CLH\ 3/2$). With the maximum water surface at elevation 4,298, the outlet tunnel will discharge approximately 1,200 second-feet, making the total flood discharge 24,600 second-feet, or slightly in excess of 10 second-feet per square mile of drainage area. It is possible that a flood of this magnitude might occur, but it is doubtful and highly improbable that such a flood flow would ever reach the proposed reservoir. A flood of 10,000 second-feet or greater would inundate a considerable portion of Mason Valley, including the city of Yerington, because of the restricted river channel and low banks. The northwest portion of Mason Valley near Wabuska is lower than the river channel a short distance above the proposed reservoir, and a flood of any magnitude would overflow this portion of the valley, breaking through into the Carson River below Churchill, Nev. A study of the graphs of maximum recorded river floods indicate that floods occurring on the upper reaches of the river have a tendency to flatten out by the time they reach Mason Valley and lose their intensity; the total run-off may be the same, but the maximum flow is reduced and the time duration increased. In other

words, the lower valleys act as retarding basins for the maximum floods occurring on the higher watersheds.

The rock outcrop at the proposed spillway location has been analyzed by the University of Nevada as andesite, a dense igneous rock generally occurring in Nevada in the form of intrusive dikes. The formation is widely distributed over the State and quite common in the mineralized districts. It is the general opinion of geologists and mining engineers that these andesite formations are of great depth. The mines at Tonopah and Goldfield have penetrated these andesite formations to depths of 2,000 feet or more. Only one hole (No. 68), was drilled in this formation because of its extreme hardness and the excessive wear on the diamond drill bits. It was necessary to reset the diamonds about every 12 feet of drilling, the steel bit becoming so badly worn. Blocky formations were encountered where it was necessary to use considerable care to avoid fracturing and breaking diamonds.

The spillway channel will flow over the rock formation to station 5+00, where the rock dips sharply downward. From this point on the channel will be in earth. It is proposed to connect this channel with a slough or side channel of the river, connecting with the main river channel approximately 1,500 feet downstream from the dam site.

A portion of spillway crest below elevation 4,291, will require a concrete floor. Retaining walls for the embankments will be required at each end of the spillway. Below the crest it is proposed to use rock from the channel excavation for riprap and dry-rubble channel banks.

FREEBOARD

It is believed that 5 feet of freeboard above the maximum water surface elevation is ample protection from wave action. From the discussion on spillway capacity, it is apparent that it is very improbable that the proposed maximum water surface condition will seldom occur. The prevailing high winds in this locality are upstream, and in the event there should be high winds blowing downstream the exposed fetch is less than 3 miles. Under these conditions, it is not likely that the wave height would exceed 2 feet. The occurrence of the two extreme conditions, a rare flood and high winds, at the same time is even more remote.

It has been observed that waves have a tendency to follow up the flat upstream face on dams, and since a considerable quantity of the blocky rock formation is available, it is planned to construct the freeboard section of the dam with steep slope, ½ to 1, of hand-laid rock, which will form an effective breakwater and reduce the width of the total dam embankment.

OUTLET WORKS

The plan of the proposed outlet works is shown on the general plan (drawing No. 4A, file W. R. 45), and details of the gate structure and outlet conduit shown on drawing No. 6B, file W. R. 50.

The tunnel will have a minimum capacity of 180 second-feet, or or approximately 1 second-foot for each 55 acres with all lands under irrigation; and a maximum capacity of 1,200 second-feet, with the reservoir water surface at elevation 4,298.00.

To economize in construction cost it was at first decided to place the outlet gate floor at elevation 4,255.00, or 10 feet above the river bed, but after a study of conditions and estimating the cost of river diversion during construction, it was concluded that under favorable normal conditions the outlet tunnel could be used to by-pass the river during construction, at least from July 1 to April 1 in ordinary years. Estimates are based upon a structure with the bottom of the tunnel at elevation 4,245.00, or at river grade. In order to conform to the lower elevation, the structure is located farther west on the dam than was shown in the preliminary report. The slough on the east side of river flood plain will serve as a diversion channel for the river. The material through which the conduit will be constructed is indurated rock, clay, and sand of a conglomerate nature and very resistant to erosion. At this location it will require 225 feet of conduit through the dam.

A spillway structure and canal heading is located approximately 500 feet downstream from the outlet of the conduit, where reservoir waters can be spilled into the river channel for the lower canals of the project and diverted to the proposed canals for the upper area. The proposed structure will be similar to the lateral headgate and wasteway structure constructed at the end of the Fort Hall main canal, and the plan of this structure is submitted as a preliminary plan (see drawing No. 6–D, F. H. 3–69) for this structure, with some modification of dimensions.

UNIT COSTS

The estimated unit costs are based upon the fact that a portion of the construction equipment required for the dam is now available for transfer at a reasonable cost from other projects in this district. The unit costs include all equipment charges and depreciation, and all field overhead items, but do not include the general overhead expense of engineering, superintendence, accounts, and contingencies, which is provided for by a percentage addition to the total cost.

Since it will be more economical to handle excavation operations and material by power excavating machines, and that they will be required on the job, it is believed that greater economy in sluicing operations will result if power excavators are used to handle and load flumes by drag line or shovel, and water pumped only for transporting material and placing in dam. The material required for the dam is located above the dam elevation, and very little power will be required for moving other materials not sluiced in. It is proposed to move this material with 2½-ton dump cars, using a small gasoline locomotive to move empty cars to borrow pits. Location of material available for construction is shown on general plan No. 4A, file W. R. 45.

HYDRAULIC FILL (SLUICING ONLY)

General conditions.—Material to be dumped into flume by gas shovel, water for sluicing to be pumped from bed of stream.

Total earth to be handled, 220,000 cubic yards.

Quantity of water to be furnished, 10 second-feet.

Ratio of earth to water in sluice, 1 to 7.

Plant layout to handle 1,000 cubic yards of earth each shift.

Allowing 5 per cent of the time for shutdowns, time required will be 294 shifts. All expenses are calculated for 294 shifts.

In case of shutdowns on the part of the shovel, which is where the delays are most likely to occur, the stationary engineer will help the operator and the laborers on the flume will help the carpenter with the flume changing.

Difference in water surfaces, 66 feet.

Friction in 800 feet of 18-inch pipe, 7 feet.

Total pumping head, 73 feet.

Theoretical horsepower required to lift 10 second-feet of water, 73 feet—82 horsepower.

Actual horsepower required, 65 per cent effective—126 horsepower.

Overhead:		
Interest on investment, 7 per cent on $30,000 for 4 months		$700. 00
Bond and insurance, 5 per cent on $60,000		3, 000. 00
Contractor's profit, 10 per cent on $60,000		6, 000. 00
Contingencies, 5 per cent on $60,000		3, 000. 00
Total		12, 700. 00
Cost per yard, $0.058.		
Equipment:		
1 1-yard gas shovel [1]	$10, 000. 00	
2 75-horsepower Holt gas engines	4, 000. 00	
1 12-inch horizontal centrifugal pump with shafts	1, 500. 00	
1 3-horsepower gas engine and 2-inch centrifugal pump	350. 00	
Picks, shovels, Ford truck, tank	1, 200. 00	
	17, 050. 00	
60 per cent depreciation on above		10, 230. 00
800 feet wood stave pipe, 18-inch diameter	$1, 600. 00	
1,400 feet flume	3, 000. 00	
15,000 feet lumber	525. 00	
	5, 125. 00	
100 per cent depreciation on above		5, 125. 00
Total		15, 355. 00
Cost per yard, $0.070.		
Fuel for pumping, 130 gallons per day, at 20 cents		$7, 644. 00
Fuel for shovel, 120 gallons per day, at 20 cents		7, 056. 00
Rental of storage tank and transportation and erection costs		700. 00
		15, 400. 00
Cost per yard, $0.070.		
Labor per shift:		
1 foreman	$7. 00	
1 operator	7. 00	
1 stationary engineer	7. 00	
1 carpenter	6. 00	
1 oiler	5. 00	
1 truck driver	4. 50	
6 laborers	24. 00	
1 cook	5. 00	
Share of camp overhead	15. 00	
	80. 50×294=	$23, 667. 00
Cost per yard, $0.107.		
Cleaning up, moving equipment, transportation, etc		$5, 000. 00
Cost per yard, $0.023.		

[1] Or 2 three-fourths cubic yard drag lines at Fort Hall.

Summary cost per yard:	
Overhead	$0.058
Equipment	.070
Fuel	.070
Labor	.107
Dismantling, etc	.022
Total per cubic yard	.327

The quantity of hydraulicked material in the different designs is variable, so to take care of smaller quantities this class of work is estimated at $0.40 per cubic yard.

EXCAVATION

Excavation by power excavators in trenches and cuts is estimated at $0.20 per cubic yard, based upon past experience; structure excavation at $0.50 per cubic yard, and hand excavation at $1 per cubic yard. Embankments placed by teams or cars, sprinkled and rolled, is estimated at $0.50 per cubic yard, an average bid of contractors in this locality for this class of work. Rock excavation in the spillway channel is estimated at $2.50 per cubic yard. This rock will break well under blasting operations and requires a minimum number of drill holes; the labor of removing is provided for in use of this rock for riprap and dry rubble spillway channel walls.

LOOSE ROCK FILL

This work is estimated at $1.50 per cubic yard. There are approximately 40,000 to 50,000 cubic yards of rock in the hill on the east end of the dam. This rock is all broken and seamed and can be excavated with a power shovel starting from a face on the south side of the hill. No stripping will be required. It will require practically no drilling and only a little blasting. The rock can be moved on dump cars to the dam by gravity. A small gasoline locomotive of the converted Fordson tractor type can haul empty cars to borrow pit. It is estimated that obtaining a quantity in excess of 50,000 cubic yards will require considerable drilling and blasting, which will add to the unit cost. Previous experience has demonstrated that scattered loose rock can be picked and hauled by team for approximately $1 per cubic yard.

CONCRETE

Reinforced concrete is estimated at $25 per cubic yard for walls, piers, and work requiring forming, and at $15 for mass work not requiring forming. This price includes cement, steel, forms, aggregate, and labor. Cement and steel can be shipped practically to the site by railroad. Gravel and sand are available at the east end of the dam. Construction costs for even the smaller structures on the project have rarely exceeded $25 per cubic yard, including excavation.

COST ESTIMATES

As previously stated, no final estimate has been prepared on design No. 2, because the excessive excavation required to remove sand and the additional quantity of material required for the upstream blanket greatly increases the cost out of proportion to other comparative estimates.

Supplemental to remarks under "Recommended design," it might be well to invite attention to the estimated costs on design No. 5, for which no section is shown on drawing. The section proposed for design No. 5 is the same as that of design No. 3 (see drawing No. 5A, file W. R.–47), except the amount of loose-rock fill is reduced and a sluiced fill of coarse gravel and sand substituted. It is proposed to place in the downstream toe a small quantity of loose rock, sufficient to fill the downstream trench and provide free drainage at the toe. In addition to features of design No. 3, steel-sheet piling across the river channel is added. This sheet piling would be driven in the bottom of the upstream cut-off trench, connecting this to the rock or clay strata below. The piling cut-off would extend approximately from hole No. 21 to hole No. 35 on section A–A (drawing No. 6C, W. R.–51), varying in depth from a few feet to a maximum depth of 30 feet in the center of the river and cover an area of approximately 5,000 square feet.

The total dam quantities in both designs Nos. 3 and 5 are less than in the other designs because of the change made in the top width, which is made 18 feet, and the fact that the freeboard section has a steep upstream slope of ½ to 1, making the total over-all width of the dam less. The same idea can be applied to the other designs, and a reduction of from 15,000 to 18,000 cubic yards in the total quantity in the dam effected.

From the summary of comparative estimates, it is apparent that the alternative designs for each type are more economical. In the alternative estimates the height of the dam is reduced 2 feet with the same storage. A portion of the spillway crest is made lower than the maximum storage elevation (4291) and the maximum storage obtained by closing radial gates in the spillway. The same spillway capacity is provided with a maximum flood water surface 2 feet lower, or at elevation 4296.00.

The total cost of the steel sheet piling across the river channel is estimated at $11,250. If this feature is substituted for upstream blanket in design No. 3 it will increase the total cost by $3,770. In design No. 1 the estimated cost of sheet piling is approximately $1,500 less than the estimated cost of the upstream blanket.

ESTIMATED COSTS

Dam design No. 1 (revised)

Storage capacity	acre-feet	30, 000
Elevation, top of dam	feet	4, 303
Elevation, spillway crest	do	4, 291
Maximum height of dam	do	58
Maximum length of main section	do	1, 570

(1) Cut-off trench, excavation, 25,000 cubic yards, at $0.20	$5, 000. 00
(2) Upstream blanket, 32,000 cubic yards, at $0.40	12, 800. 00
(3) Dam:	
Concrete core wall, rock excavation, 25 cubic yards, at $4	100. 00
Concrete core wall, 56 cubic yards concrete, at $25	1, 400. 00
Rock fill, 40,500 cubic yards, at $1.50	60, 750. 00
Clay-fill, sprinkled and rolled, 122,000 cubic yards, at $0.50	61, 000. 00
Hydraulic fill, 142,500 cubic yards, at $0.40	57, 000. 00
Riprap, hand-placed, 8,900 cubic yards, at $1.50	13, 325. 00

(4) Outlet works:	
Excavation, 5,224 cubic yards, at $0.25	$1, 306. 00
Excavation, 4,000 cubic yards, at $0.50	2, 000. 00
Concrete. 400 cubic yards, at $25	10, 000. 00
Gates and hoists (installed)	4, 500. 00
Canal heading and outlet spillway, 150 cubic yards, at $25	3, 750. 00
Radial gate and headgates (outlet spillway)	750. 00
Gatehouse, footbridge, etc	1, 000. 00
(5) Spillway:	
Excavation, rock, 6,140 cubic yards, at $2.50	15, 350. 00
Excavation, earth, 40,000 cubic yards, at $0.20	8, 000. 00
Dry rubble (heavy riprap), 1,000 cubic yards, at $1.50	1, 500. 00
Grouted riprap, 1,500 cubic yards, at $1.50	2, 250. 00
Retaining walls, 260 cubic yards concrete, at $25	6, 500. 00
Spillway crest, 300 cubic yards concrete, at $15	4, 500. 00
Suspension footbridge across spillway	400. 00
(6) Embankment (west end spillway), 14,000 cubic yards, at $0.35	4, 900. 00
(7) Embankment (Wabuska Slough), 8,000 cubic yards, at $0.35	2, 800. 00
(8) Stream control (dike provided by excavation of upstream cut-off trench)	3, 000. 00
(9) Right of way (Parker Ranch)	8, 600. 00
(10) Engineering, superintendence, and contingencies, 20 per cent	58, 496. 20
Total estimated cost	350, 977. 20
Cost per acre-foot of storage	11. 70

Alternative design No. 1 (revised)

Storage capacity acre-feet	30, 000
Elevation, top of dam feet	4, 301
Elevation, Spillway Crest (260 feet main section) do	4, 291
Elevation, Spillway Crest (100 feet section) do	4, 285
Maximum height of dam do	56
Maximum length of main section do	1, 560
(1) Cut-off trench, excavation, 25,000 cubic yards, at $0.20	$5, 000. 00
(2) Upstream blanket, 32,000 cubic yards, at $0.40	12, 800. 00
(3) Dam:	
Concrete core wall, rock excavation, 25 cubic yards, at $4	100. 00
Concrete core wall, 56 cubic yards concrete, at $25	1, 400. 00
Rock fill, 37,000 cubic yards, at $1.50	55, 500. 00
Clay fill, sprinkled and rolled, 111,000 cubic yards, at $0.50	55, 500. 00
Hydraulic fill, 129,500 cubic yards, at $0.40	51, 800. 00
Riprap, hand-placed, 8,350 cubic yards, at $1.50	12, 525. 00
(4) Outlet works:	
Excavation, 5.224 cubic yards, at $0.25	1, 306. 00
Excavation, 4,000 cubic yards, at $0.50	2, 000. 00
Concrete, 394 cubic yards, at $25	9, 850. 00
Gates and hoists (installed)	4, 500. 00
Canal heading and outlet spillway, 150 cubic yards, at $25	3, 750. 00
Radial gate and headgates (outlet spillway)	750. 00
Gatehouse, footbridge, etc	1, 000. 00
(5) Spillway:	
Excavation, rock, 6,500 cubic yards, at $2.50	16, 250. 00
Excavation, earth, 40,900 cubic yards, at $0.20	8, 180. 00
Dry rubble (heavy riprap), 1,000 cubic yards, at $1.50	1, 500. 00
Grouted riprap, 1,500 cubic yards, at $1.50	2, 250. 00
Retaining walls, 250 cubic yards, at $25	6, 250. 00
Spillway crest, 300 cubic yards, at $15	4, 500. 00
Radial gate piers, 35 cubic yards, at $25	875. 00
Five 6 by 20 foot radial gates with hoists, at $750 each (installed)	3, 750. 00
Suspension footbridge across spillway	400. 00
(6) Embankment (west end of spillway), 12,000 cubic yards, at $0.35	4, 200. 00

(7) Embankment (Wabuska Slough), 8,000 cubic yards, at $0.35	$2, 800. 00
(8) Stream control (dike provided by excavation of upstream cut-off trench)	3, 000. 00
(9) Right of way (Parker Ranch)	8, 600. 00
	280, 336. 00
Engineering, superintendence, and contingencies, 20 per cent	56, 067. 20
Total estimated cost	336, 403. 20
Cost per acre-foot of storage	11. 20

Dam design No 3 (revised)

Storage capacity ... acre-feet	30, 000
Elevation, top of dam ... feet	4, 303
Elevation, spillway crest ... do	4, 291
Length of spillway crest ... do	360
Maximum height of dam ... do	58
Maximum length of dam ... do	1, 570
(1) Cutoff trench, excavation, 25,000 cubic yards, at $0.20	$5, 000. 00
(2) Upstream blanket, 18,700 cubic yards, at $0.40	7, 480. 00
(3) Dam:	
Rock fill, 35,130 cubic yards, at $1.50	52, 695. 00
Hydraulic fill, 206,460 cubic yards, at $0.40	82, 584. 00
Clay blanket, sprinkled and rolled, 21,600 cubic yards, at $0.50	10, 800. 00
Riprap, dumped rock, 9,000 cubic yards, at $1	9, 000. 00
Riprap, dumped gravel, 10,000 cubic yards at $0.50	5, 000. 00
Cut-off wall, concrete, 56 cubic yards, at $25	1, 400. 00
Cut-off wall, rock excavation, 25 cubic yards at $4	100. 00
Breakwater, dry rubble, 870 cubic yards, at $1.50	1, 305. 00
(4) Outlet works, excavation, 5,225 cubic yards, at $0.25	1, 306. 00
Excavation, 4,000 cubic yards, at $0.50	2, 000. 00
Concrete, 400 cubic yards, at $25	10, 000. 00
Gates and hoists (installed)	4, 500. 00
Gatehouse, footbridge, etc	1, 000. 00
Canal heading and spillway structure, concrete, 150 cubic yards, at $25	3, 750. 00
Gates and lifts	750. 00
(5) Spillway:	
Earth excavation, 40,000 cubic yards, at $0.20	8, 000. 00
Rock excavation, 6,140 cubic yards, at $2.50	15, 350. 00
Dry rubble and grouted riprap, labor placing rock from excavation, 2,500 cubic yards, at $1.50	3, 750. 00
Retaining walls, concrete, 260 cubic yards, at $25	6, 500. 00
Crest, concrete, 300 cubic yards, at $15	4, 500. 00
Footbridge across channel	400. 00
(6) Embankment (west end of spillway), 14,000 cubic yards at $0.35	4, 900. 00
(7) Embankment (Wabuska Slough), 8,000 cubic yards at $0.35	2, 800. 00
(8) Stream control during construction (dike provided by excavation of upstream cut-off trench)	3, 000. 00
(9) Right of way (Parker Ranch)	8, 600. 00
	256, 470. 00
Engineering, superintendence, accounting, and contingencies, 20 per cent	51, 294. 00
Total estimated cost	307, 764. 00
Cost per acre-foot of storage	10. 26

Alternative design No 3 (revised)

Storage capacity ... acre-feet	30, 000
Top of dam, elevation ... feet	4, 301
Spillway crest, 260 feet, elevation 4291; 100 feet, elevation ... do	4, 285

Maximum height of dam ..... feet	56
Maximum length of dam ..... do	1, 560
(1) Cut-off trench, excavation, 25,000 cubic yards, at $0.20	$5, 000. 00
(2) Upstream blanket, 18,700 cubic yards, at $0.40	7, 480. 00
(3) Dam:	
Rock fill, 32,400 cubic yards, at $1.50	48, 600. 00
Hydraulic fill, 188,030 cubic yards, at $0.40	75, 212. 00
Clay blanket, upstream face, 20,700 cubic yards, at $0.50.	10, 350. 00
Riprap, dumped rock, 9,000 cubic yards, at $1	9, 000. 00
Riprap, dumped gravel, 9,000 cubic yards, at $0.50	4, 500. 00
Breakwater, dry rubble, 870 cubic yards, at $1.50	1, 305. 00
Cut-off wall, concrete, 56 cubic yards, at $25	1, 400. 00
Cut-off wall, rock excavation, 25 cubic yards, at $4	100. 00
(4) Outlet Works:	
Excavation 5,224 cubic yards, at $0.25	1, 306. 00
Excavation, 4,000 cubic yards, at $0.50	2, 000. 00
Concrete, 394 cubic yards, at $25	9, 850. 00
Gates and hoists (installed)	4, 500. 00
Gatehouse, footbridge, etc	1, 000. 00
Canal heading and spillway structure	4, 500. 00
(5) Spillway:	
Earth excavation 40,900 cubic yards, at $0.20	8, 180. 00
Rock excavation, 6,500 cubic yards, at $2.50	16, 250. 00
Dry rubble and grouted riprap, labor placing rock from excavation, 2,500 cubic yards, at $1.50	3, 750. 00
Retaining walls, concrete, 250 cubic yards, at $25	6, 250. 00
Crest, concrete, 300 cubic yards, at $15	4, 500. 00
Gate piers, concrete, 35 cubic yards, at $25	875. 00
Five 6 by 20 foot radial gates and hoists at $750 each (installed)	3, 750. 00
Suspension footbridge across spillway channel	400. 00
(6) Embankment (west end of spillway), 12,000 cubic yards, at $0.35	4, 200. 00
(7) Embankment (Wabuska Slough), 8,000 cubic yards, at $0.35	2, 800. 00
(8) Stream control and diversion	3, 000. 00
(9) Right of way (Parker Ranch)	8, 600. 00
Engineering, superintendence, and contingencies, 20 per cent	49, 731. 60
Total estimated cost	298, 389. 60
Cost per acre-foot of storage	9. 95

Dam design No. 4 (revised)

Storage capacity ..... acre-feet	30, 000
Elevation, top of dam ..... feet	4, 303
Elevation, spillway crest (360 feet) ..... do	4, 291
Maximum height of dam ..... do	58
Maximum length of main section ..... do	1, 570
(1) Cut-off trench, excavation, 20,000 cubic yards, at $0.20	$4, 000. 00
(2) Downstream blanket, rock fill, 30,000 cubic yards, at $1.50	45, 000. 00
(3) Dam:	
Concrete core wall, rock excavation, 25 cubic yards, at $4	100. 00
Concrete core wall, 56 cubic yards, at $25	1, 400. 00
Rock fill, 38,000 cubic yards, at $1.50	57, 000. 00
Clay, sand, and gravel fill, 267,000 cubic yards, at $0.40	106, 800. 00
Riprap, hand-placed, 8,900 cubic yards, at $1.50	13, 325. 00
(4) Outlet works:	
Excavation, 5,224 cubic yards, at $0.25	1, 306. 00
Excavation, 4,000 cubic yards, at $0.50	2, 000. 00
Concrete, 400 cubic yards, at $25	10, 000. 00
Gates and hoists (installed)	4, 500. 00
Canal heading and outlet spillway, 150 cubic yards, at $25	3, 750. 00
Radial gates and headgates (outlet spillway)	750. 00
Gatehouse and footbridge, etc	1, 000. 00

(5) Spillway:	
Excavation, rock, 6,140 cubic yards, at $2.50	$15, 350. 00
Excavation, earth, 40,000 cubic yards, at $0.20	8, 000. 00
Dry rubble (heavy riprap), 1,000 cubic yards, at $1.50	1, 500. 00
Grouted riprap, 1,500 cubic yards, at $1.50	2, 250. 00
Retaining walls, 260 cubic yards, at $25	6, 500. 00
Spillway crest, 300 cubic yards, at $15	4, 500. 00
Suspension footbridge across spillway	400. 00
(6) Embankment (west end of spillway), 14,000 cubic yards, at $0.35	4, 900. 00
(7) Embankment (Wabuska Slough), 8,000 cubic yards, at $0.35	2, 800. 00
(8) Stream control (dike provided by excavation of upstream cut-off trench)	3, 000. 00
(9) Right of way (Parker Ranch)	8, 600. 00
	308, 731. 00
Engineering, superintendence, and contingencies, 20 per cent	61, 746. 20
Total estimated cost	370, 477. 20
Cost per acre-foot of storage	12. 35

Alternative design No. 4 (revised)

Storage capacity acre-feet	30, 000
Elevation, top of dam feet	4, 301
Elevation, spillway crest (260 feet main section) do	4, 291
Elevation, spillway crest (100 feet radial gate section) do	4, 285
Maximum height of dam do	56
Maximum length of main section do	1, 560
(1) Cut-out trench, excavation, 20,000 cubic yards, at $0.20	$4, 000. 00
(2) Downstream blanket, rock fill, 30,000 cubic yards, at $1.50	45, 000. 00
(3) Dam:	
Concrete core wall, rock excavation, 25 cubic yards, at $4	100. 00
Concrete core wall, 56 cubic yards, at $25	1, 400. 00
Rock fill, 35,000 cubic yards, at $1.50	52, 500. 00
Clay, sand, and gravel fill, 241,900 cubic yards, at $0.40	96, 760. 00
Riprap, hand-placed, 8,350 cubic yards, at $1.50	12, 525. 00
(4) Outlet works:	
Excavation, 5,224 cubic yards, at $0.25	1, 306. 00
Excavation, 4,000 cubic yards, at $0.50	2, 000. 00
Concrete, 394 cubic yards, at $25	9, 850. 00
Gates and hoists (installed)	4, 500. 00
Canal heading and outlet spillway, 150 cubic yards, at $25	3, 750. 00
Radial gate and headgates (outlet spillway)	750. 00
Gatehouse, footbridge, etc	1, 000. 00
(5) Spillway:	
Excavation, rock, 6,500 cubic yards, at $2.50	16, 250. 00
Excavation, earth, 40,900 cubic yards, at $0.20	8, 180. 00
Dry rubble (heavy riprap), 1,000 cubic yards, at $1.50	1, 500. 00
Grouted riprap, 1,500 cubic yards, at $1.50	2, 250. 00
Retaining walls, 250 cubic yards, at $25	6, 250. 00
Spillway crest, 300 cubic yards, at $15	4, 500. 00
Radial gate piers, 35 cubic yards, at $25	875. 00
Five 6 by 20-foot radial gates with hoists, at $750 each (installed)	3, 750. 00
Suspension footbridge across spillway	400. 00
(6) Embankment (west end of spillway), 12,000 cubic yards, at $0.35	4, 200. 00
(7) Embankment (Wabuska Slough), 8,000 cubic yards, at $0.35	2, 800. 00
(8) Stream control (dike provided by excavation of upstream cut-off trench)	3, 000. 00
(9) Right of way (Parker Ranch)	8, 600. 00
	297, 996. 00
Engineering, superintendence, and contingencies, 20 per cent	59, 599. 20
Total estimated cost	357, 595. 20
Cost per acre-foot of storage	11. 92

Dam design No. 5 (revised)

Capacity, storage ... acre-feet	30, 000
Top of dam, elevation ... feet	4, 303
Spillway crest, elevation ... do	4, 291
Length of spillway ... do	360
Maximum length of dam ... do	1, 570
Maximum heighth of dam ... do	58

This design has the same maximum section as design No. 3, except that only 12,000 cubic yards of loose rock are used in the downstream toe and steel sheet piling is added. Coarse gravel and sand is sluiced in as a substitute for the loose rock omitted.

(1) Cut-off trench, excavation, 25,000 cubic yards at $0.20	$5, 000. 00
(2) Upstream blanket, 18,700 cubic yards, at $0.40	7, 480. 00
(3) Steel sheet piling across river channel, 5,000 square feet, 175,000 pounds, at $0.05	8, 750. 00
Driving piling, at $0.50 square foot	2, 500. 00
(4) Dam:	
Rock fill, 12,000 cubic yards, at $1.50	18, 000. 00
Hydraulic fill, 229,630 cubic yards, at $0.40	91, 852. 00
Clay blanket, upstream face, 21,600 cubic yards, at $0.50	10, 800. 00
Riprap, dumped rock 9,000 cubic yards, at $1	9, 000. 00
Riprap, dumped gravel, 10,000 cubic yards, at $0.50	5, 000. 00
Breakwater wall, dry rubble, 870 cubic yards, at $1.50	1, 305. 00
Cut-off wall, concrete and excavation	1, 500. 00
(5) Outlet works (items and cost same as dam design No. 3) (total)	23, 306. 00
(6) Spillway (items and cost same as dam design No. 3) do	38, 500. 00
(7) Embankment (west end of spillway), 14,000 cubic yards, at $0.35	4, 900. 00
(8) Embankment (Wabuska Slough), 8,000 cubic yards, at $0.35	2, 800. 00
(9) Stream control and diversion	3, 000. 00
(10) Right of way (Parker Ranch)	8, 600. 00
	242, 293. 00
Engineering, superintendence, accounting, and contingencies, 20 per cent	48, 458. 60
Total estimated cost	290, 751. 60
Cost per acre-foot of storage	9. 69

Alternative design No. 5 (revised)

Storage capacity ... acre-feet	30, 000
Top of dam, elevation ... feet	4, 301
Spillway, 260 feet, elevation ... do	4, 291
Spillway, 100 feet, elevation ... feet, with gates	4, 285
Maximum length of dam ... feet	1, 560
Maximum heighth of dam ... do	56

This design has the same maximum section as design No. 3-A, except that only 12,000 cubic yards of loose rock are used in the downstream toe and steel sheet piling is added. Coarse gravel and sand is sluiced in as a substitute for the loose rock omitted.

(1) Cut-off trench, excavation, 25,000 cubic yards, at $0.20	$5, 000. 00
(2) Upstream blanket, 18,700 cubic yards, at $0.40	7, 480. 00
(3) Steel sheet piling across river channel, 5,000 square feet, 175,000 pounds, at $0.05	8, 750. 00
Driving 5,000 square feet, at $0.50 per square foot	2, 500. 00
(4) Dam:	
Rock fill, 12,000 cubic yards, at $1.50	18, 000. 00
Hydraulic fill, 208,430 cubic yards, at $0.40	83, 372. 00
Clay blanket, upstream face, 20,700 cubic yards, at $0.50	10, 350. 00
Riprap, dumped rock, 9,000 cubic yards, at $1	9, 000. 00
Riprap, dumped gravel, 9,000 cubic yards, at $0.50	4, 500. 00
Breakwater wall, dry rubble, 870 cubic yards, at $1.50	1, 305. 00
Cut-off wall, concrete and excavation	1, 500. 00

(5) Outlet works (items and cost same as dam design No. 3–A) (total)	$23, 156. 00
(6) Spillway (items and cost same as dam design No. 3–A) do	43, 955. 00
(7) Embankment (west end of spillway), 12,000 cubic yards, at $0.35	4, 200. 00
(8) Embankment (Wabuska Slough), 8,000 cubic yards, at $0.35	2, 800. 00
(9) Stream control and diversion	3, 000. 00
(10) Right of way (Parker Ranch)	8, 600. 00
	237, 468. 00
Engineering, superintendence, accounting, and contingencies, 20 per cent	47, 493. 60
Total estimated cost	284, 961. 60
Cost per acre-foot of storage	9. 50

SUMMARY OF ESTIMATED COSTS

Rio Vista Dam designs—Storage capacity, 30,000 acre-feet

Dam design	Elevation top of dam	Estimated cost	Cost per acre-foot	Dam design	Elevation top of dam	Estimated cost	Cost per acre-foot
No. 1	4, 303	$350, 977. 20	$11. 70	No. 4	4, 303	$370, 477. 20	$12. 35
No. 1–A	4, 301	336, 403. 20	11. 20	No. 4–A	4, 301	357, 595. 20	11. 92
No. 3	4, 303	307, 764. 00	10. 26	No. 5	4, 303	290, 751. 60	9. 69
No. 3–A	4, 301	298, 389. 60	9. 95	No. 5–A	4, 301	284, 961. 60	9. 50

MECHANICAL ANAYLSES OF MATERIAL

River sand from surface of river bed

[Volume of semple, 446 cubic centimeters ($\frac{1}{63}$ of a cubic foot). Weight, natural, 657.7 grams. Weight, dry, 632.2 grams. Porosity, 31.5 per cent. Effective size, weight per cubic foot, 92.8 pounds. Effective size, 0.25 millimeter]

Sieve analysis

Size of sieve	Weight	Per cent	Volume	Per cent
	Grams		*Cubic centimeter*	
Retained on 2.362 millimeters	20. 3	0. 032	14	0. 031
Retained on 1.168 millimeters	72. 2	. 114	49	. 108
Retained on 0.589 millimeter	200. 4	. 317	144	. 318
Retained on 0.295 millimeter	263. 0	. 416	180	. 399
Retained on 0.147 millimeter	62. 1	. 098	51	. 113
Passing 0.147 millimeter	14. 0	. 022	15	. 033
Total	632. 0	. 999	453	1. 002

Sand from hole No. 33, 25 feet below river bed

[Volume of sample, 446.45 cubic centimeters. Weight, natural, 842.7 grams. Weight, dry, 700.7 grams. Porosity, 32 per cent. Clay content, 2.1 per cent by weight. Weight per cubic foot, 103.1 pounds (dry). Effective size, 0.19 millimeter]

Size of sieve	Weight	Per cent	Volume	Per cent
	Grams		*Cubic centimeter*	
Retained on 2.362 millimeters	6. 5	0. 009	5	0. 016
Retained on 1.168 millimeters	12. 4	. 018	10	. 021
Retained on 0.589 millimeter	121. 8	. 173	80	. 170
Retained on 0.295 millimeter	446. 6	. 637	297	. 630
Retained on 0.147 millimeter	88. 2	. 126	63	. 134
Passing 0.147 millimeter	24. 7	. 036	16	. 034
Total	700. 2	. 999	471	1. 005

Sand from hole No. 34, 27 feet below river bed

[Volume of sample, 445 cubic centimeters. Weight, dry, 718.7 grams. Porosity, 24.5 per cent. Clay content, 13.7 per cent (volume). Effective size, 0.147 millimeter]

Size of sieve	Weight	Per cent	Volume	Per cent
	Grams		*Cubic centimeter*	
Retained on 2.362 millimeters	5.90	0.008	4.5	0.001
Retained on 1.168 millimters	23.52	.033	16.0	.034
Retained on 0.589 millimeter	107.60	.149	69.5	.148
Retained on 0.295 millimeter	372.00	.518	235.0	.500
Retained on 0.147 millimeter	138.58	.193	97.0	.207
Passing 0.147 millimeter	70.90	.099	48.0	.102
Total	718.50	1.000	470.0	.992

Sand from hole No. 36 on top of rock under blue clay (15 feet deep)

[Volume of sample, 442.46 cubic centimeters. Weight, natural, 652.6 grams. Weight, dry, 651.2 grams. Porosity, 57 per cent. Effective size, 0.21]

Size of sieve	Weight	Per cent	Volume	Per cent
	Grams		*Cubic centimeters*	
Retained on 0.589 millimeter	4.6	0.007	5	0.010
Retained on 0.295 millimeter	493.0	.758	352	.765
Retained on 0.147 millimeter	117.9	.181	83	.180
Passing 0.147 millimeter	34.4	.053	21	.043
Total	649.9	.999	461	.998

Sand and clay from hole No. 40—General sample from 10 to 14 feet

[Volume of sample, 500 cubic centimeters. Weight, dry, 779.9. Porosity, 39 per cent. Clay content, 5.3 per cent (volume). Effective size, 0.167 millimeter]

Size of sieve	Weight	Per cent	Per cent finer than—	Volume	Per cent
	Grams			*Cubic centimeters*	
Retained on 4.499 millimeters	11.5	0.015	0.985	10	0.020
Retained on 2.362 millimeters	14.8	.019	.966	10	.020
Retained on 1.168 millimeters	40.1	.051	.915	29	.054
Retained on 0.589 millimeter	169.9	.218	.697	122	.244
Retained on 0.295 millimeter	397.4	.509	.188	275	.550
Retained on 0.147 millimeter	80.5	.103	.085	67	.134
Passing 0.147 millimeter	65.0	.083	----------	54	.108
Total	779.2	.998	----------	567	1.130

Sand and clay from hole No. 40—Sample core from 14 to 16 feet

[Volume of sample, 510 cubic centimeters. Weight, dry, 720 grams. Uniformity coefficient, 3.8. Porosity, 34 per cent. Clay content, 0.065 for entire sample. Effective size, 0.11 millimeter]

Size of sieve	Weight	Per cent	Per cent finer than—	Volume	Per cent
	Grams			*Cubic centimeters*	
Retained on 4.609 millimeters	10.2	0.014	98.6	8	0.015
Retained on 2.362 millimeters	27.8	0.39	94.7	22	.043
Retained on 1.168 millimeters	35.2	0.49	80.8	28	.054
Retained on 0.589 millimeter	79.6	.11	78.8	57	.111
Retained on 0.295 millimeter	361.6	.50	28.8	250	.488
Retained on 0.147 millimeter	124.3	.172	11.6	88	.171
Passing 0.147 millimeter	80.7	.121	----------	59	.115
Total	719.4	1.005	----------	512	.997

Sand and clay from hole No. 40—Sample at 22 foot depth

[Volume of sample, 300 cubic centimeters. Weight, dry, 450 grams. Effective size, 0.003 millimeter (assumed). Porosity, 39 per cent. Clay content, 0.105 (volume). Effective size, 0.10 millimeter]

Size of sieve	Weight	Per cent	Per cent finer than—	Volume	Per cent
	Grams			*Cubic centimeters*	
Retained on 4.699 millimeters	6.0	0.013	0.987	5	0.015
Retained on 2.362 millimeters	4.4	.009	.978	4	.012
Retained on 1.168 millimeters	19.7	.043	.935	14	.043
Retained on 0.589 millimeter	108.7	.240	.695	79	.243
Retained on 0.295 millimeter	162.0	.361	.334	112	.345
Retained on 0.147 millimeter	88.2	.195	.139	63	.192
Passing 0.147 millimeter	60.5	.132	----------	47	.145
Total	449.5	.993	----------	324	.995

Sand and clay from hole No. 40—Sample at 24 to 25 feet depth

[Volume of sample, 450 cubic centimeters. Weight, dry, 767 grams. Effective size, 0.003 millimeter. Porosity, 38 per cent. Clay content, 0.106 (volume)]

Size of sieve	Weight	Per cent	Per cent finer than—	Volume	Per cent
	Grams			*Cubic centimeters*	
Retained on 4.699 millimeters	14.2	0.018	0.982	9	0.017
Retained on 2.362 millimeters	78.0	.102	.880	55	.106
Retained on 1.168 millimeters	220.7	.287	.593	145	.280
Retained on 0.589 millimeter	196.8	.256	.437	127	.246
Retained on 0.295 millimeter	127.0	.165	.172	85	.164
Retained on 0.147 millimeter	59.2	.077	.095	42	.081
Passing 0.147 millimeter	70.2	.091	----------	55	.106
Total	766.7	.996	----------	518	1.000

Sand and clay from hole No. 42—Sample at 16 feet

[Volume of sample, 375 cubic centimeters. Weight, dry, 521.6 grams. Porosity, 42 per cent. Clay content, 0.055 (volume). Effective size, 0.263 millimeter]

Size of sieve	Weight	Per cent	Volume	Per cent
	Grams		*Cubic centimeters*	
Retained on 4.699 millimeters	22.0	0.042	14	0.037
Retained on 2.362 millimeters	10.3	.021	8	.021
Retained on 1.168 millimeters	9.8	.019	8	.021
Retained on 0.589 millimeter	55.5	.116	42	.111
Retained on 0.295 millimeter	312.6	.60	230	.61
Retained on 0.147 millimeter	75.4	.145	54	.142
Passing 0.147 millimeter [1]	35.9	.069	27	.072
Total	521.5	1.012	383	1.014

[1] Plus 16.6 washed out of sample.

Sand and clay from hole No. 42.—Sample at 20-foot depth

[Volume of sample, 500 cubic centimeters. Weight, dry, 705.7 grams. Porosity, 41 per cent. Clay content, 12 per cent (volume). Effective size, 0.10 millimeter]

Size of sieve	Weight	Per cent	Volume	Per cent
	Grams		*Cubic centimeters*	
Retained on 4.699 millimeters	0	0	0	0
Retained on 2.362 millimeters	0.5	0.007	Trace.	0
Retained on 1.168 millimeters	12.2	.018	10	0.051
Retained on 0.589 millimeter	196.1	.294	138	.269
Retained on 0.295 millimeter	374.7	.562	275	.535
Retained on 0.147 millimeter	82.0	.123	61	.119
Passing 0.147 millimeter	38.6	.054	30	.058
Total	704.1	1.058	514	1.032

38.6 grams washed; 18.2 grams clay washed out; 17.5 grams remaining.

Sand and clay from hole No. 42—Sample at 16-foot depth—Analysis after washing and drying

[Weight of sample, 469 grams. Effective size, 0.10 millimeter]

Size of sieve	Weight	Per cent	Volume	Per cent
	Grams		*Cubic centimeters*	
Retained on 4.699 millimeters	19.3	0.041	14	0.037
Retained on 2.362 millimeters	11.3	.024	8	.021
Retained on 1.168 millimeters	18.5	.040	8	.021
Retained on 0.589 millimeter	32.4	.069	42	.111
Retained on 0.295 millimeter	272.5	.581	230	.610
Retained on 0.147 millimeter	101.0	.215	54	.142
Passing 0.147 millimeter	13.7	.029	27	.072
Total	468.7	.999	383	1.014

Sand and clay from hole No. 42—Sample at 20-foot depth—Analysis after washing and drying

[Weight of sample, 647.3 grams. Porosity, 41 per cent. Clay content, 12 per cent (volume). Effective size, 0.08 millimeter]

Size of sieve	Weight	Per cent
	Grams	
Retained on 2.362 millimeters	0.3	0.005
Retained on 1.168 millimeters	12.7	.020
Retained on 0.589 millimeter	186.6	.289
Retained on 0.295 millimeter	306.1	.474
Retained on 0.147 millimeter	122.8	.190
Passing 0.147 millimeter	17.5	.027
Total	646.0	1.005

Clay and decomposed rock from hole No. 74—Sieve analysis after washing and drying

[Volume, 315 cubic centimeters. Weight of sample, 379.3 grams. Effective size, 0.05 millimeter]

Size of sieve	Weight	Per cent	Volume	Per cent
	Grams		*Cubic centimeter*	
Retained on 2.362 millimeters	49.5	0.130	42	0.103
Retained on 1.168 millimeters	54.5	.143	33	.130
Retained on 0.589 millimeter	48.6	.128	51	.125
Retained on 0.295 millimeter	88.3	.232	105	.257
Retained on 0.147 millimeter	59.7	.158	73	.179
Passing 0.147 millimeter	78.5	.207	83	.203
Total	379.1	.998	387	.997

NOTE.—Passing 0.147 millimeter=0.133 per cent by weight of whole sample. Retained on 0.147 millimeter=0.010 per cent by weight of whole sample. Retained on 0.295 millimeter=0.15 per cent by weight of whole sample.

Sand from hole No. 87, east end of dam

[Volume, 442.5 cubic centimeters. Weight, dry, 788.4 grams. Weight, dry, 110.6 pounds per cubic foot. Porosity, 36 per cent. Effective size, 0.12 millimeter]

Size of sieve	Weight	Per cent	Volume	Per cent
	Grams		*Cubic centimeters*	
Retained on 2.362 millimeters	21.0	0.026	15	0.027
Retained on 1.168 millimeters	113.1	.144	80	.147
Retained on 0.589 millimeter	296.3	.377	199	.366
Retained on 0.295 millimeter	210.6	.268	146	.268
Retained on 0.147 millimeter	57.0	.073	41	.075
Passing 0.147 millimeter	88.5	.112	64	.117
Total	786.5	1.000	545	1.000

35557—27——9

Seepage and percolation tests

Hole No.	Depth	Thickness of sample in feet	Head in feet	Quantity of water in gallons	Time in minutes	Area in square feet	Gallons per minute: By test	Gallons per minute: Slichter's formula	Rate in second-feet per square foot (test)	Temperature about 40°	Remarks
33	Surface	1.33	4	27	127	0.1365	0.21	(0.074)	0.00345	° 40	
33	do	2	4	11	94	.1365	.117	(.049)	.00192	40	
33	3 feet	1.33	4	6	85	.1365	.070	(.074)	.00102	40	
[1] 33	22 feet	.83	230.54	1	12	.0168	.083			40	
[1] 33	do		276.69	4	3	.0168	1.333			40	Washed hole below end of casing.
[1] 33	do		161.54	1.5	6	.0168	.25			40	
[1] 33	21 feet		126.9	15	5	.0168	3			40	
[2] 33	31 feet		60	.2	5	.0145	.04		.00615	40	Drop 6.
[2] 33	do		60	.16	5	.0145	.032		.00492	40	
[2] 33	do		145.38	3.03	5	.0145	.61		.0937	40	
[2] 33	do		92.31	2	5	.0145	.40		.0615	40	
[2] 33	do		184.62	5	5	.0145	1		.1533	40	
[2] 33	do		461.08	1.5	1	.0145	1.50		.231	40	
34	18 to 27 feet	1.67	4.09	1.62	431	.1365	.00376	(.00375)	.000061	40	K, assumed 0.0015.
34	do	1.33	4.20	1	125	.1365	.008	(.00485)	.000131	40	Do.
[1] 40	18 feet		46.15	7.5	5	.024	1.5			40	Washed hole below casing.
[1] 40	do		92.31	18.5	5	.024	3.7			40	Do.
[1] 40	do		138.46	28	5	.024	5.6			40	Do.
40	14 to 34 feet	1.92	4.17	2	4,230	.1365	.00047	(.00143)	.0000077	40	Effective size assumed, 0.03.
100	5 feet	2	4.25	7	232	.1365	.030	(.0226)	.000493	40	K, assumed 0.10.
River.	Surface	2.33	39.25	20	4.75	.49	4.20	(1.49)	.0186	39	
River.	do	2	22.77	20	9.2	.49	2.12	(1.09)	.0093	40	
River.	do	2.33	33.48	20	5.25	.49	3.81	(1.274)	.0168	40	
River.	do	2.33	60.02	20	12	.49	1.66	(2.19)	.0074	40	
River.	do	2.33	60.02	10	98	.49	.102	(2.19)	.00045	40	10 feet of clay on top of sand.
74	15 feet	2	59.69	5	210	.49	.024	(.09)	.0001	40	
74	do	2	59.69	5	181	.49	.027	(.09)	.00012	46	

[1] Area at bottom indeterminate.
[2] Values doubtful; area at bottom of casing probably does not represent correct area of application.

US0006546

No. 1681

UNIVERSITY OF NEVADA,
STATE MINING LABORATORY,
Reno, Nev., September 9, 1926.

Walker River irrigation project, Schurz, Nev.

Report on sample received from you on September 7, 1926, as follows:

Sample marked	Minerals or rock
1.	Andesite or andesite breccia weathered from hole near river.
2.	Andesite porphyry, from hole No. 68.

These rocks are dense, finely crystalline, normally very resistant to weathering.
Specific gravity, 2.94. Weight per cubic foot, 184 pounds.
O. R. G., analyst.

W. S. PALMER,
Director State Mining Laboratory.

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